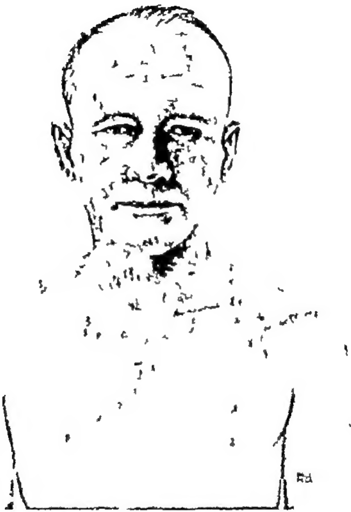

Chloracne and Melanosis

Worker employed in hydrochloric acid plant where soft coal was mixed with salt to make cake more easily acted on by sulfur dioxide and steam to give an increased yield of hydrochloric acid. The heat evolved coal tar gases from the soft coal which were chlorinated by the hydrochloric acid forming waxy chlorinated hydrocarbon, the cause of chloracne. That part of the coal tar which was not acted upon by the hydrochloric acid was the cause of the melanosis.

OCCUPATIONAL DISEASES OF THE SKIN

BY

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THIS BOOK

IS RESPECTFULLY DEDICATED

TO

L. R. THOMPSON M D

ASSISTANT SURGEON GENERAL, UNITED STATES PUBLIC HEALTH SERVICE

WHO CONCEIVED AND ORGANIZED THE OFFICE OF

DERMATOSES INVESTIGATIONS AND

WHOSE CONTINUED INTEREST AND SUPPORT HAVE MADE POSSIBLE

THE WORK ON WHICH THIS BOOK IS BASED

PREFACE TO THE SECOND EDITION

THE new chemicals and new methods of manufacture which are so rapidly and constantly being evolved bring with them new skin hazards to workers engaged in their manufacture and in their application as well as to the public who use products containing these chemicals.

The skin is a shock organ and is the first line of defense against outside irritants Therefore industrial dermatoses constitute the largest part of industrial illness.

This book is the attempt of the authors to give to the profession in a detailed and systematized manner the result of their own observations as to industrial processes and the skin hazards connected with them as well as the reports of numerous other workers in the same field

The authors wish to acknowledge their indebtedness to the many writers whose works and observations have been wholly or partially incorporated in this book and to those who so generously placed their photographs at their disposal.

The authors are particularly indebted to Paul C Campbell, Jr., Surgeon, USPHS for the time he has devoted in correcting galley and page proofs of this edition

Such pertinent industrial processes are briefly described as will enable the reader to have an understanding as to where in the process and how the dermatitis is contracted.

Methods of prevention and treatment are described in general and more specifically in certain industries.

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CHAPTER X

Dermatoses Caused by Physical and Mechanical Agents

CHAPTER XI

Dermatoses Caused by Inorganic Acids and Organic Acids

CHAPTER XII

Dermatoses Caused by Alkalis

CHAPTER XIII

Dermatoses Caused by Metals

CHAPTER XIV

CHAPTER XV

Dermatoses Caused by Carbon, Coal Tar, and Coal Tar Products

CHAPTER XVI

Dermatoses Caused by Petroleum

CHAPTER XVII

CHAPTER XVIII

Dermatoses in Synthetic Dye Manufacture

CHAPTER XIX

Dermatoses Due to Fabric Dyeing

CHAPTER XX

Dermatitis From Wearing Apparel

CHAPTER XXI

Cosmetics

CHAPTER XXII

Electroplating

CHAPTER XXIII

Dermatoses Caused by Explosives

CHAPTER XXIV

Dermatoses Caused by War Gases

CHAPTER XXV

Dermatoses Caused by Furs

CHAPTER XXVI

Dermatoses From Glass Manufacture

CHAPTER XXVII

Dermatoses Caused by Insecticides and Fungicides

CHAPTER XXVIII

Dermatoses in Leather Manufacture

CHAPTER XXIX

Liquor Industry

CHAPTER XXX

Dermatoses Caused by Paints, Varnishes and Lacquers

CHAPTER XXXI

Dermatoses in Photographing, Photoengraving, Lithographing, Printing, Typewriting and Hectographing

CHAPTER XXXII

Dermatoses Caused by Resins and Waxes

CHAPTER XXXIII

Dermatoses in the Manufacture of Rubber

CHAPTER XXXIV

Dermatoses Caused by Silk (Natural and Artificial)

CHAPTER XXXV

Dermatoses Caused by Organic Solvents

CHAPTER XXXVI

Sugar Industry

CHAPTER XXXVII

CHAPTER XXXVIII

Irritant Plants and Woods

CHAPTER XXXIX

Dermatoses Caused by Animal Parasites

CHAPTER XL

Dermatoses Caused by Bacterial Infections

CHAPTER XLI

Occupational Dermatoses From Mycotic Infections

CHAPTER XLII

OCCUPATIONAL CANCER

CHAPTER XLIII

OCCUPATIONAL DISEASES OF MUCOUS MEMBRANES

CHAPTER XLIV

OCCUPATIONAL DISEASES OF THE NAILS

CHAPTER XLV

Analysis of Skin Hazards in One Hundred and Fourteen Occupations

CHAPTER XLVI

CHAPTER XLVII

Occupational Diseases of the Skin

INTRODUCTION

The text-books on industrial diseases usually devote only a chapter to the subject of industrial dermatoses. The same holds true for most text-books on dermatology. Yet industrial dermatoses are of more frequent occurrence than the total of all other industrial diseases and it is now known that external irritants are the causes of many skin diseases the etiology of which were not previously known. The more we know of industrial processes and chemicals the more we realize their importance as causes not only of industrial dermatoses but of dermatoses among the general public or consumers of manufactured products. Besides this the intact skin is the principal portal of entry for many industrial systemic poisons and a diseased skin or an injured skin may be the point of entrance for microörganisms which may cause not only local but also systemic infections.

It is the purpose of this book to describe the known sources of industrial and other contact dermatoses, the known methods for their prevention and treatment, so that physicians may be cognizant of them and thus be better prepared to make etiologic diagnoses of dermatoses occurring among workers and institute approved methods of treatment and prevention.

It is hoped that this book will also assist the employer, the safety engineer, the plant physician, the insurance carrier, and the worker to a better understanding of industrial skin hazards and thus retard the growing incidence of industrial dermatoses.

CHAPTER I

HISTORICAL DATA

Paracelsus (1493–1541) in his *Morbis Metallicus* was the first to write about occupational diseases and among them he noted changes in the skin caused by salt compounds.

At about the same period, Agricola, in his book on diseases of metal workers, described the deep ulcers which he observed among them.

However, it was not until the year 1700 that there appeared a book in which was given a clear, detailed description of the occupational skin diseases of that day.

Bernardino Ramazzini (1633–1714) in his classical work *De Morbis Artificum Diatriba* made many observations on occupational skin diseases that remain true even to this day. He noted that bakers had strong, thick hands, but that they often became swollen and painful as a result of dough kneading. He observed also that millers and sievers of corn contracted an itching dermatitis, which he stated was caused by an invisible parasite present in cereals. This was a most remarkable observation considering that Ramazzini did not make use of a microscope. He described fissures caused by lye on the hand of washerwomen, ulcers of the legs among salt miners, fissures of the arms and callosities on the buttocks of hostlers due to riding, varicose veins and ulcers of the legs of workers whose occupation necessitated long-continued standing, and he observed that bath attendants contracted skin diseases from people they massaged. He noted that midwives suffered from dermatitis of the hands caused by secretions of the genitals and he refers to a case of primary lues on the hand of a midwife, which was first described by Fernelius. Ramazzini's work was so thorough and explicit that while some modifications and changes were later made, it remained the standard text on occupational diseases for more than a century.

In 1775, Percival Pott, an Englishman, was the first to describe chimney sweep's cancer of the scrotum. He said it was caused by soot which penetrated the clothing and became rubbed into the scrotum as the sweep went down the chimney. Other English and French writers later confirmed the carcinogenic properties of carbon.

In the early part of the nineteenth century there was a revival of interest in occupational dermatoses. In England, Robert Willan first described dermatitis among shoemakers due to shoemaker's wax. Thomas Bateman, a pupil of Willan's, described dermatitis among sugar and spice handlers and differentiated between vesicular and pustular eruptions among builders, caused by lime. C. Turner Thackrah first described dermatitis among tobacco workers and

first emphasized the value of personal cleanliness in the prevention of occupational diseases.

The French writers were not idle during this period. Alibert described herpes and other skin diseases occurring among workers exposed for long periods to the rays of the sun. He also noted the occurrence of favus among animal handlers. Rayer described a pustular eruption among arsenic workers. He also noted that cow-pox and glanders can be transmitted to man. Ibrelule observed that anthrax was carried by imported hides and advocated their sterilization by boiling water.

Potton first described dermatitis among silk winders. Lespian in 1859 described dermatitis caused by coal tar. Bazin, in 1862 published a classification of the causes of occupational dermatoses.

In 1863 Becourt and Chevalier described dermatitis caused by potassium dichromate. Devergie and Hardy in 1870 stated that certain persons had a latent predisposition to contact dermatitis.

In Germany Cazenave and Schedel as early as 1839 stated that excessive perspiration predisposed to occupational dermatitis. Von Blandit described changes in the skin caused by arsenical pigments. Halforto wrote a treatise on dermatoses of artists and craftsmen in which he describes dermatitis among gilders, caused by mercury. In the same period Hebra, Eulenberg and Hirt also made notable contributions to the literature on occupational dermatoses.

As a result of these and other works, too numerous to mention the interest of legislators was aroused and laws were made to compensate workers first for industrial accidents, later for certain industrial diseases and still later for certain industrial skin diseases. Germany and France were the first countries to enact such laws.

Dermatologists began to devote more attention to contact dermatoses. In Germany Blaschko Jadassohn, Bloch Mayer Oppenheim and others wrote extensively on the subject describing new industrial skin diseases and formulating methods of diagnosis, treatment, and prevention. In England since 1900 McLeod R Prosser White, Bridge, Sequeira, Percival and others have contributed notable works to industrial dermatology.

In the United States there has been an added interest in occupational diseases since the World War when the chemical industry in the United States underwent a great revival and expansion. Since then valuable contributions have been made to our knowledge of industrial and other forms of contact dermatoses by writers like Gardiner Fordyce Lane, Downing Foerster Sulzberger Hayhurst Hamilton and many others. Interest in the subject became so great that in 1928 the United States Public Health Service organized the Office of Dermatoses Investigations, which is concerned almost exclusively with the study of occupational and other forms of contact dermatoses. Now the majority of the states have laws which compensate the worker for occupational skin diseases caused by the substances which have been found to be skin hazards in that particular state and a few of them compensate for all skin diseases that

can be shown to be of occupational origin. In some of the states where there are laws in effect compensating for occupational accidents, occupational diseases have been ruled to be accidents and are thus included in the compensation laws.

Legislation in foreign countries varies greatly and is more or less in conformity with the country's leading industries. Great Britain and her colonies all have laws compensating for specifically stated occupational skin diseases. In Great Britain itself the compensation laws include dermatitis due to dusts and liquids, dermatitis due to the toxic wood *Gonioma kamassi*, ulcerations due to chromium, inflammations, ulcerations and malignant lesions due to roentgen-rays or radioactive substances, scrotal epithelioma and epitheliomatous cancer or ulceration of the skin from pitch, tar, bitumen, mineral oil and paraffine or their compounds, products or residues.

In Western Australia the law compensates for ulcerations from chromium, eczematous lesions caused by caustic or corrosive liquid, dermatitis caused by work in mines or quarries, scrotal cancer and epitheliomatous cancer and ulcerations of the skin due to mineral oil, pitch, and tar or its compounds.

In South Africa the law compensates for dermatitis from cyanides.

In Queensland there is compensation for miner's itch, itch from copper, dermatitis from toxic woods, mineral oil, pitch, and tar and from work in acid mineral waters, and ulceration from chromates.

In Canada each province has its own laws. Alberta compensates for frost-bite, New Brunswick for dermatitis caused by work on sugar, and British Columbia for dermatitis caused by the toxic wood *Juniperus virginiana*.

Italy compensates for recurrent dermatitis, erythema and eczema caused by foreign woods and by tar, skin infections of the hands of railroad workers caused by the prolonged effect of corrosive substances.

In Japan there is compensation for dermatitis caused by hydrocyanic acid and its derivatives, dermatitis due to cement and tar, dermatitis of the fingers caused by handling silk, eczema of grinders, corrosions and ulcerations caused by mineral acids, caustic alkalis, chlorine, fluorine, chromium, and tar and their derivatives, and by other corrosive substances used in industry.

The U. S. S. R. compensates for serious affections of the skin, incurable cases of dermatitis, and for inflammations, malignant tumors, and atrophies due to roentgen-rays.

CHAPTER II

COMPENSATION FOR OCCUPATIONAL DERMATOSES

This is more of a legal than a medical subject but a physician should at least have a general comprehension of the medico-legal phases of occupational dermatoses. Occupational dermatoses which were but lightly regarded fifteen years ago are now considered of sufficient importance to be covered by the compensation laws of 28 of our states. Even in those states where the compensation laws do not include dermatoses, the patient has the right of legal action in the regular courts of law.

Workmen's compensation laws are effective in all but one of our states. There is also a federal compensation law applicable to federal workers and to longshoremen and harbor workers.

While the compensation laws of the various states are different yet there is a common intent to extend the benefits of the law to those occupational diseases commonly occurring in the respective states. There is today a keener recognition of occupational skin hazards by the compensation laws and many of the states in which the compensation laws do not cover skin diseases will soon remedy this fault.

In the early compensation laws it was usually necessary to find that a skin condition or disease was caused by an "industrial accident." Yet in the nature of things, the very condition or disease suffered by an employee was one which did not readily permit of ascribing it to an industrial accident; rather it was due in the normal case to an "occupational disease" which, unless specifically mentioned in the law, deprived the employee of its benefits.

By "industrial accident" is meant an event which takes place fortuitously and at a fixed time and without one's foresight or expectation; one which proceeds from an unknown cause or is an unusual effect of a known cause and therefore not expected.

An "occupational disease" is one which results from the nature of the employment, and by "nature" is meant not those conditions brought about by the failure of the employer to furnish a safe place to work, but conditions to which all employees of a class are subject and which produce the disease as a natural incident of a particular occupation and attach to that occupation a hazard which distinguishes it from the usual run of occupations and is in excess of the hazard attending employment in general.*

The distinguishing feature between the two is to be found in the fact that an industrial accident connotes suddenness as the cause while an occupational disease requires time. Or in other words

* Matter of Goldberg v. 954 Marcy Corp., 276 N. Y. 313.

one requires immediacy as the cause the other extended exposure over a period of time

If a distinction is to be drawn between an industrial accident and an occupational disease it is not difficult to reconcile what may at first appear to be complications arising out of similar situations. Why in certain instances is dermatitis (venenata) covered and not in others?

In consideration of this phase of our problem it is of course necessary briefly to revert to the language of the statutory provision of the different states.

In one form or another in nearly all states the Act applies to personal injuries arising out of and during the course of employment and such disease or infection as may naturally and unavoidably result therefrom. These are considered "industrial accidents." If the evidence warrants a finding that dermatitis (venenata) is within this statutory definition the law applies.

Attempts however under former statutory provisions to secure compensation for disability due to dermatitis (venenata) caused by contacts with acids or other irritants presented difficulties whereas these conditions were considered to be "occupational diseases"

Dermatitis (venenata) at the time of earlier decisions was not included as an "occupational disease" and for a disability due to dermatitis, apart from an accidental injury compensation could not be had

It may readily be seen from the fact that contact with acids or other irritants was frequent in the performance of work with the gradual development of an injurious result, that the affliction could not be attributed to any one definite contact with the irritants unless it was a distinct chemical burn. If it was dermatitis no date place or happening could be pointed out as marking the beginning of the affliction The disease was not due to any cut or injury There was nothing catastrophic or extraordinary in the happening to which the inception of the disease could be attributed

We find much the same situation in all states without "occupational disease" legislation We can therefore readily understand decisions disallowing compensation for dermatitis (venenata) caused by cement poisoning or disallowing claim for dermatitis (venenata) suffered in an oil refining plant as the laws of the states in which they were rendered contained no provision for any such condition unrelated to an industrial accident.

These decisions were quite harsh to the claimants. It was so recognized by the legislatures of some states which by statutory enlargement of the compensation law extended its benefits to include as an "occupational disease" dermatitis (venenata) The language of the statute in some cases is quite specific New York for example specifies "any process involving the use of or direct contact with acids alkalis acids or oils or with brick cement lime concrete or mortar capable of causing dermatitis (venenata)" It is unimportant therefore in such circumstances whether the

employee establishes "industrial accident" or "occupational disease," as in either event the beneficient provisions of the law apply to him. In time other states may see the wisdom of adopting similar legislation. At the present time the laws of some states with "occupational disease" legislation may not be so favorable to a claimant as that in New York. For while it must be assumed that an employee may be entitled to receive benefits whenever he can establish an "industrial accident" yet because of the difficulty of establishing such an accident we find a gradual extension in the different states of legislation to apply to "occupational disease." Thus far in the states of Arkansas, California, Connecticut, Delaware, Idaho, Illinois, Indiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, Washington, Wisconsin, Utah and in the District of Columbia, Hawaii, Puerto Rico and Virgin Islands (and under the Federal Longshoremen's Act) we find some express provisions for occupational disease coverage. Mississippi is the only state that has no compensation laws.

All states do not view "occupational disease" in the same light. Some feel that it should come within the provisions of the Workmen's Compensation Act while others feel differently. This is not difficult to understand in the light of the fact that a hazard peculiar to one state may not find a counterpart in another since many industries vary according to territorial differences.

A mining state, for example, or one whose main industry is pottery (ceramics) may feel that *silicosis* is a hazard peculiar to the conduct of industries in that state and therefore regard it as an "occupational disease." Another state industrial in character may feel that some other disease is peculiar to an industry there and make special provision with respect to that disease which is a normal concomitant of such industry. While some states may not have so comprehensive a workmen's compensation disease act as can be found for instance, in the States of Illinois and Indiana, yet such states do have provisions making the act applicable to special hazards as those states may view them. However dermatitis (venenata) is not considered such a special hazard in any of those states. For example in the State of Delaware we find a listing of twelve occupational diseases, none of which expressly includes dermatitis (venenata). In this and other states with similar laws it must be manifest that any difficulty which may present itself in establishing a valid claim arises from the evidential factor requiring some relationship between the process involved and the disease suffered. This, of course, is not to say that an award may not be properly allowable, rather that the claimant does not have the same easy road which he would have in other states where legislation is much clearer upon the subject.

Some states adopt a method of listing in parallel columns a descrip-

tion of the diseases and a description of the processes. New York may be taken as an example

Description of disease	*Description of process*
Dermatitis (venenata)	Any process involving the use of or direct contact with acid alkalis acid or oil, or with brick, cement lime concrete or mortar capable of causing dermatitis (venenata)

This method of presentation has been adopted in other jurisdictions including Michigan and Minnesota. Still it is entirely possible (as in New York) that the same disease may be included within the grouping as an occupational disease thus

Description of disease	*Description of process*
Poisoning by carbon bisulphide or its sequelæ or any sulphide	Any process involving the use of or direct contact with carbon bisulphide or its preparations or compounds, or any sulphide

Some other jurisdictions are not so specific as the states already mentioned with respect to the inclusion of dermatitis (venenata) as an occupational disease Still there can be very little question that skin conditions due to an industrial process are within the benefits of the law

As an illustration we may cite Pennsylvania In that state nothing is expressly stated with respect to dermatitis (venenata) but still there can be very little room for doubt that skin conditions are within the protection of the law which reads as follows

> (i) Infection or inflammation of the skin or other contact surfaces due to oils cutting compounds, lubricants, dust liquids, fumes, gases, or vapor in any occupation involving direct contact with handling thereof or exposure thereto

Other states (jurisdictions) adopting this method of treatment include New York North Carolina Ohio Rhode Island and Washington and the island of Puerto Rico Some states as for example Connecticut contain a general provision such as the following

> The word occupation disease shall mean a disease peculiar to the occupation in which the employee was engaged and due to causes in excess of the ordinary hazards or employment as such.

Here too there can be little question that skin conditions are included Some states (jurisdictions) have special workmen's compensation disease acts or other acts generally applicable to occupational diseases. These include the District of Columbia the States of Illinois Indiana Arkansas, Idaho California Connecticut Hawaii Massachusetts New York North Dakota Ohio

Wisconsin and Washington These 14 states have comprehensive disease acts leaving it without question that skin conditions are within the provisions of the law In these states no difficulty will ever present itself in establishing a valid claim for dermatitis (venenata) It is utterly unimportant whether the claimant will be able to establish an industrial accident as in these states the fact that the condition is contracted within the employment itself creates liability under the act

Some states (jurisdictions) have special provisions within the Act with respect to some (but not all) occupational diseases. These states usually list groupings of occupational diseases which are considered extra-hazardous in those states. Dermatitis (venenata) is not included by mention, yet the benefits of the Act may be secured in any case in which the evidence discloses a causal relation between the condition and the process involved States (jurisdictions) adopting this method of treatment include Delaware New Jersey North Carolina Nebraska and the Virgin Islands.

Some states (jurisdictions) have limited coverage for occupational diseases. California may be cited as an example

> Injury includes any injury or disease arising out of employment.

Other states (jurisdictions) have no provision with respect to occupational diseases yet most of them will permit a recovery for such diseases in any case where there is a causal relation between the primary injury and the subsequent disease Such states (jurisdictions) include Alabama Alaska, Arizona, Colorado Florida Georgia, Iowa, Kansas Louisiana Maine Montana Nevada New Hampshire New Mexico Oklahoma Oregon, South Carolina South Dakota, Tennessee, Vermont Virginia and Wyoming

In these states, it is necessary to repeat that, from the fact that no provision has been made either by special workmen s compensation disease acts or special provisions within the Workmen s Compensation Act it does not follow that a claimant otherwise entitled to secure the benefits of the law may not successfully prosecute his claim for dermatitis (venenata) Here however the difficulty which presents itself is evidential These states contain provisions which give benefits to those injured by industrial accidents. Yet we have seen that by statutory definition the term "industrial accidents" has been sufficiently broadened to include any disease if it can be shown to be related causally to the accident.

Dermatitis (venenata) as an occupational disease may or may not be attributed to or follow from the accident. Still to come within the benefits of the laws in those states it is necessary that evidence be furnished that the accident in some fashion may have induced or causally produced the dermatitis (venenata)

It is beyond the scope of this present discussion, however to discuss varying situations in which the condition may have been so caused and those in which there may not have been any such relation. Suffice it to say here that every case in which the claim-

ant succeeded was made to depend entirely upon the existence of competent evidence furnished through proper witnesses that the dermatitis (venenata) was caused as herein mentioned

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CHAPTER III

INCIDENCE OF INDUSTRIAL SKIN DISEASE

In England between 1921 and 1929 there was an annual average of 769 cases of compensated occupational dermatoses or about 56 per cent of all occupational diseases. In the three-year period of 1930–1932 inclusive there was an annual average of 1,308 cases of occupational dermatoses or about 72 per cent of all occupational diseases in that country. In 1936 there were 1 771 cases of occupational dermatoses with an additional 142 cases of occupational epitheliomas and 84 cases of chrome ulceration. All other occupational diseases compensated in 1936 totalled 428 cases. The three agents chiefly responsible were oils alkalis and friction and heat and the largest number of affected workers were engineers.

It is stated by English writers that these figures do not represent the actual incidence of occupational dermatoses because only those workers who are incapacitated for one week or more and who receive compensation are reported. R. Prosser White estimated that at least 18,000 to 19 000 cases occurred in England each year.

The yearly incidence of occupational dermatoses in Germany is not available but in 1935 the number of reported cases of occupational diseases, not including dermatoses, was 8 001. Of this number 2 137 were in the metal industries.

There are no complete statistics from Italy but Levi found 50 cases of occupational dermatoses occurring among 1 156 workers in a period of six months or an annual rate of 9 per cent.

The reports of the compensation boards of seven states show that about 5 per cent of all compensated occupational injuries are occupational diseases and that about 65 per cent of the occupational diseases are dermatoses.

Proportion of Occupational Dermatoses to all Dermatoses.—Many variable factors enter into the different estimates, the chief ones being (1) the percentage of the industrial workers to the general population (2) the prevailing types of industry in the localities where the estimates are made and (3) the criteria used in arriving at a diagnosis.

Fordyce states that occupational dermatoses constitute 2 per cent of all skin diseases. C. Guy Lane states that they comprise from 4 to 5 per cent. R. Prosser White gives the figure as 6 per cent. Gardiner places it at 7.5 per cent. Oppenheim estimates that 20 per cent of all skin diseases are of occupational origin and states that occupational eczema is the most frequent of all skin diseases.

In our own studies of records in New York free clinics in 1930 we found only 58 cases diagnosed as occupational dermatoses among

25,000 new skin cases. This is a very low percentage and may be due to the fact that the occupational histories of the patients were not carefully taken and patch tests were but seldom performed. Many cases of occupational dermatoses were probably lost in the large number diagnosed as eczema and as dermatophytosis.

A more accurate conception of the prevalence of occupational dermatoses can be obtained by studying their incidence in the various industries. The Public Health Service made studies among more than 100,000 workers in various factories and found that in the period of a year about 1 per cent of all workers in these factories were affected with occupational dermatoses. These figures do not include burns, splashes of acids or alkalis, or pyogenic infections of occupational skin wounds, which affected about 10 per cent of 72,000 workers in an automobile factory and about 10 per cent of 2,500 workers in a chemical and dye factory. The findings in twelve different industries are given in Table 1.

TABLE 1.—YEARLY PREVALENCE OF OCCUPATIONAL DERMATOSES IN INDUSTRY

Industry	Number of workers	Dermatoses	Per cent
Synthetic resin manufacture	700	53	7.8
Chemicals and dye manufacture	2,500	176	7
Tanneries	565	20	3.5
Oil refining	14,000	472	3.3
Candy manufacture	1,336	36	3
Fabric dyeing	4,000	76	2
Rayon manufacture	4,000	80	2
Steel manufacture	3,300	52	1.5
Fur dyeing	1,600	1	1
Rubber manufacture	8,000	84	1
Glass manufacture	6,700	64	1
Automobile manufacture	72,000	281	0.4
Totals	117,001	1403	1.2

Because the workers in the above-listed industries are seemingly exposed to contact with strong alkalis, acids, solvents, and oils, we would expect to find a larger percentage of occupational dermatoses among them than among workers in trades where such primary irritants are not handled. Yet this is not necessarily true, because in most of the factories there are safety devices such as enclosed processes and forced ventilation which minimize the possibility of contact, and it will be later shown that just as large a number of occupational dermatoses are reported to occur among the workers in domestic service, personal service, and food-handling trades. Therefore, it is conservative to estimate that 1 per cent of the industrial workers in the United States (not including clerical workers) are annually affected with occupational dermatoses.

A study of 41,025 cases of occupational dermatitis reported to the U. S. Public Health Service by 7 states shows wide differences in the occurrence of dermatitis cases from a particular industry or occupation among the 7 reported states. The principal material exposures were petroleum products, alkalis, solvents, and plants.

TABLE 2.—CAUSES OF OCCUPATIONAL DERMATITIS.

Material exposure	Number	Per cent
Petroleum products and greases	7,806	18.8
Alkalis (and cement)	4,851	11.7
Solvents	3,266	7.8
Plants and woods	2,710	6.5
Metals and metal plating	2,483	6
Rubber and its compounds	1,314	3.3
Burns, physical and mechanical agent	1,313	3.2
Chemicals unspecified	1,253	3
Paints, enamels and varnishes	1,132	2.7
Acids and acid fumes	976	2.4
Dyes and dye intermediates	974	2.3
Chromates and chromic acid	737	1.7
Biologic agents	550	1.3
Coal tar products	462	1.1
Furs and fur dyes, and hides	425	1
Synthetic resins	390	0.9
Non-metallic elements	168	0.4
Oils, vegetable (oils, fats, and waxes)	92	0.2
All other known exposures	8,064	19.4
Unknown exposures	2,647	6.4
Totals	41,628	100

These reports also show a lack of uniformity in the reporting of occupational dermatoses which makes it difficult to evaluate the actual irritants and actual diagnoses. The minimum required data in reporting cases should contain

Name of employee

Race Age Sex

Employer's Name

Address

Industry

Work performed by employee

Material causing dermatitis

How proved

By whom

A study of the compensation records of the several states shows that the average loss of time per year for compensated cases of occupational dermatoses is about ten weeks and the average compensation paid is about $100. In addition there is an average cost of medical care of about $100. It is therefore estimated that the annual loss from occupational dermatoses in the United States is approximately $100,000,000.

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CHAPTER IV

CLASSIFICATION OF CAUSES OF OCCUPATIONAL DERMATOSES

PREDISPOSING CAUSES

THE defense mechanism of the skin against external irritants consists of the cornified cells of the outermost layer and the secretions of the glands of the skin. The cornified cells are insoluble in water and alcohol and will withstand the action of even fairly strong acids but are attacked by alkalis and sulphides. The perspiration acts as a diluent of irritants which are water-soluble, and the sebaceous secretions consisting of cholesterol and liquid waxes form a protective coating against water-soluble irritants. The pigment of the skin also acts as a protective agent against certain irritants for instance light. Perspiration and sebaceous matter may however under certain conditions serve to promote the action of irritants on the skin.

The vulnerable portions of the skin are the openings of ducts and hair follicles through which certain chemical compounds especially those which are fat-soluble may easily enter. Any thinning or break in the cornified layer of the epithelium also acts as a portal of entry for external irritants.

All matters affecting the vulnerable portions of the skin or its defense mechanism play a part in its sensitivity to external irritants. The first of these factors which we will consider is race.

Race.—Although occupational dermatitis is often seen in negroes, yet it is well known in industry that the negro is less susceptible to the action of certain skin irritants than the white man. In such occupations as work on grinders and driers in dye factories where there is exposure to irritating dust and dyes many industrial concerns will employ only negroes because they have found by actual experience that negroes are less sensitive to skin irritation. The same is true of dry cleaning establishments, where cutaneous irritation from solvents is a major hazard.

On the other hand the negro race is for unknown reasons especially subject to the development of keloids which often follow a burn cut or other traumatic injury.

In the Mongolian race we have noted that the skin seems to be much drier than that of the white man owing to the lack of oil. These people exhibit a tendency to xeroderma, and are especially sensitive to friction and pressure and prone to develop eczematous lesions.

Type of Skin.—Different types of skin within the Caucasian race also differ in sensitivity. Many factories will not employ persons with thin blonde skin in occupations that would bring them in

contact with potential irritants. Workers having thick oily skin withstand the action of fat solvents such as soaps, turpentine, naphtha, benzol, trichlorethylene and carbon tetrachloride better than those with dry skin. On the other hand, in occupations where oils, greases or waxes are apt to soil the clothing, as in oil refineries, machine shops, garages, etc., we have observed that individuals with hairy arms and legs and seborrheic skin are more likely to develop acne-like lesions and folliculitis.

In a certain glass factory where an outbreak of folliculitis occurred among workers whose clothes became saturated with oil, it was noted that the most severe cases occurred in those workers having the most hair on the legs and arms and that the smooth-skinned ones escaped entirely.

In a study of skin hazards among workers with the chlorinated napthalenes and diphenyls, it was found that, while all the workers who were exposed for a length of time developed comedones and acne-like lesions, the worst cases occurred among men with dark, swarthy, oily skin who were in the acne age. The older men, especially those with fair skin, had very few pustules, or none at all, but simply yellowish non-inflammatory comedones or cysts.

Various portions of the skin of the same individual differ in susceptibility to external irritants. We have found in our studies that the inner surfaces of the forearm and the upper arm, where the skin is comparatively thin, are more often affected by occupational dermatitis and are more sensitive to patch tests than, for instance, the skin of the back. We also noted that the palms are but rarely affected by industrial dermatitis, although they are more exposed than other parts of the skin.

Perspiration.—While perspiration acts normally as a protective agent by diluting those external irritants that are already in solution, we have observed that workers who perspire excessively are more likely to develop dermatitis from solid substances which become irritants only when moist, as for instance, calcium oxide, which in the presence of moisture becomes slaked lime (calcium hydroxide), and substances such as sodium carbonate or soda ash, which irritate only when they are in solution.

A substance in order to affect the skin must wet it and will act on it either by a chemical combination or by extracting moisture or fat from the skin. That means that only those substances which are more or less soluble or miscible in the secretions of the skin are capable of producing irritation.

Excessive perspiration combined with friction will also macerate the skin and will thus make it less resistant to the action of external irritants.

The pH of the perspiration is of importance in that it affects the solution of irritant on the skin. It has been shown by Talbert and Rosen that the pH of perspiration varies in different individuals and at different times in the same individual anywhere from 4.5 to 7.5, a range from marked acidity to alkalinity. In a factory manufactur

ing calcium cyanamide a fertilizer and a source of commercial ammonia, it was noted that nearly all of the workers affected with dermatitis from this material had an alkaline perspiration as tested with litmus paper in the axilla. One explanation for this may be that the alkaline lime which caused the irritation in these workers was neutralized on the skin of those having an acid perspiration.

Diet.—The diet of the worker influences the pH of perspiration and may in this and other ways be a factor in susceptibility to industrial dermatitis Mayer and Sulzberger in 1931 showed that diet influences sensitization in guinea-pigs T Saito has shown that the sensitivity of the skin of rabbits to croton oil was increased when they had been rendered acidotic by a diet of oats, or by oral administration of hydrochloric acid or by the subcutaneous administration of a solution of sodium oxalate. He noted that cutaneous sensitivity in rabbits also increased by rendering them alkalotic by intravenous administration of sodium bicarbonate. However the *sensitivity of the skin was reduced even below normal when hydrochloric acid was administered to a rabbit which had been previously* rendered alkalotic or when a solution of sodium bicarbonate was administered to a rabbit which had been rendered acidotic He also noted fairly constant changes in the relative proportions of the electrolytes of the skin accompanying the changes in intensity of response of the skin to external irritation. In states of heightened sensitivity there was a high calcium-potassium ratio and an increase in the total weight of the calcium whereas in states of lower sensitivity the reverse was observed. Saito suggests that non-specific desensitization might be sought in the rapid reversal of the disturbed acid-base equilibrium in states of heightened sensitivity of the skin The vitamin content of the diet may also influence the usceptibility of the skin to the action of skin irritants.

Age.—In addition to the predisposition to acne at adolescence age seems to have an influence on sensitivity to external irritants. Most of the workers affected with acute industrial dermatitis are young and new workers. This may be either because they have not become immune or "hardened" to the chemicals or because they are less careful in handling them On the other hand the chronic eczematoid types of industrial dermatitis usually occur in workers of middle age and beyond.

Sex.—The skin of women is more sensitive to external irritants than that of men due to its greater dryness. Much of the dermatoses among women consist of keratosis pilaris. Women are also prone to notice slight irritations of the skin of which men would pay no attention. During menstruation and gestation there is an increase of perspiration that might well be a factor in greater sensitivity at such times. For these reasons, the records might be expected to show a larger incidence of industrial dermatoses among women than among men. The fact that fewer claims for compensation are actually made by women may be due to three factors (1) that women are usually more cleanly in their habits and more disposed

to wash after work and thus remove possible irritants from the skin and (2) that fewer women than men are employed in hazardous occupations and statistics do not show the proportion of women affected with dermatitis to the total number of women thus employed and (3) that women seek first aid for skin diseases earlier than men and thus prevent the more severe dermatoses for which compensation is claimed

Season of Year—Occupational dermatitis is on the whole more prevalent in warm weather when little clothing is worn and contact with external irritants is more likely to occur. Excessive perspiration is also more apt to occur in warm weather. In those industries, however in which the clothes become saturated with skin irritants or where dust filters through the clothing dermatitis may arise more frequently in winter because in cold weather the men are less inclined to take cleansing shower baths after work.

Other Skin Diseases.—Preexisting diseases, especially those of the itching type in which scratching tends to rub in any irritant that may be deposited on the skin also predispose to contact dermatitis. Aside from the thinning and breaks of the horny epithelium caused by these diseases, it has been noted that those workers who suffer from non-occupational skin diseases are more prone to develop industrial dermatitis than those who are free from such conditions. Persons under treatment with arsphenamine are also more subject to dermatitis. The presence of mycotic infections and the phytids is also said to predispose to contact dermatitis. This has not been proven. Except for the fact that there may be ulcerations and excoriations of the skin as a result of the mycoses, it is difficult to see why intact portions of the skin of a person having a mycotic infection should be more susceptible to an external irritant than the intact skin of a person having no mycoses.

Cleanliness—A clean environment including walls and floors of workrooms clean machines and air kept free from irritating fumes vapors and dusts will diminish the susceptibility of workers to industrial dermatitis. Personal cleanliness is of equal importance. Clean underclothes and work clothes every day in conjunction with a daily shower bath after work to remove potential irritants from the skin and the immediate washing away of accidental splashes of corrosive material during work, are important factors in the prevention of sensitivity. In addition eating places connected with the plant should be kept in a sanitary condition and the workers should be instructed to wash their hands thoroughly and carefully remove soil from beneath the nails before eating. This is particularly imperative among workers who come in contact with chemicals which cause systemic poisoning such as lead radium etc

In some instances the wearing of clothes saturated with chemicals with which the worker comes in contact during his employment will cause dermatitis in his home. Cases have been seen in which the wife and child of workers with chlorinated naphthalenes and diphen-

yls contracted severe acnes on the face shoulders, and thighs from contact with the dirty work and underclothes which were worn home from the shop

It must be observed at this point, however that cleansing chemicals are often in themselves a cause of dermatitis The use of caustic soaps, turpentine gasoline and similar strong solvents should ordinarily be rigorously avoided Numerous cases of industrial dermatitis have arisen from this cause alone The substitution of a bland soap or of sulfonated castor oil has often cleared up troublesome cases which had been attributed to substances used in the work.

Allergy —Before this subject can be clearly discussed we must first define our terms. There has been considerable confusion in the use and meaning of the words allergy" "hypersensitivity" hyposensitivity "immunity and anaphylaxis.

Allergy was a word first coined by von Pirquet and Schick—to denote an altered reactivity in humans or animals caused by a first contact with a substance and manifested after an interval of time (period of incubation) upon second contact with the original or an identical substance

The chemical causes of occupational dermatoses may be divided into primary irritants and sensitizers.[1]

A *Primary Cutaneous Irritant* is an agent which will cause dermatitis by direct action on the normal skin at the site of contact if it is permitted to act in sufficient intensity or quantity for a sufficient length of time.

A *Cutaneous Sensitizer* is an agent which does not necessarily cause demonstrable cutaneous changes on first contact but may effect such specific changes in the skin that after five to seven days or more further contact on the same or other parts of the body will cause dermatitis.

A primary irritant has a definite chemical or physical action on that portion of the skin with which it comes in contact. It forms a chemical combination with the skin or abstracts essential ingredients from it, resulting in total destruction, burn or in inflammation depending on the concentration of the chemical and the period of exposure

A primary irritant may also be a sensitizer Exposure to it may so condition the skin that further contact with even such dilute solutions or for such a short time as would not before have caused any trouble may now result in dermatitis.

Undoubtedly deficiencies in the defense mechanism of the skin renders it more vulnerable to the action of primary irritants Every one is sensitive to the action of primary irritants, but those having physiological anatomical or traumatically inflicted defects of the skin are hypersensitive Such a hypersensitivity is not specific and the resulting dermatitis is due to the chemical or physical action of

[1] Allergic Occupational Dermatitis in Our War Industries, Dr L Schwartz, Annals of Allergy Sept -Oct 1944

the chemical on that particular portion of the skin Any other primary irritant may have the same effect The hypersensitivity is localized to the vulnerable area of the skin For instance ammonium nitrate in solution has but little effect on the normal skin but will attack sites of abrasion Such a dermatitis should not be called allergic Dermatitis should only be called allergic if it occurs as a result of an induced generalized sensitivity after a period following exposure to a substance which is not a primary irritant in the concentration to which exposure occurred

For instance a wool dyer with apparently normal skin develops dermatitis after exposure for seven days to a dye containing 0.5 per cent of potassium dichromate and patch tests on distant sites of normal skin with this concentration give positive reactions. Potassium dichromate in strong concentration is a primary skin irritant but 0.5 per cent will not affect the normal skin. Therefore such a dermatitis can be called allergic.

Then again a worker with tetryl or TNT will work for seven days or more before developing dermatitis and patch tests on distant sites of normal skin give positive reactions This is also allergic because neither TNT nor tetryl will affect the normal skin

Such an induced sensitivity or allergy is specific and present all over the skin It is not confined to any particular vulnerable area However it is also true even in allergic dermatitis that open abrasions or sites having thin layers of epithelium may be more sensitive than normal areas of skin.

There is no sensitivity before exposure to substances that are not primary irritants but five days or longer after exposure a certain percentage of those exposed become sensitized The percentage sensitized is directly proportional to the degree of exposure For instance about 2 per cent of workers handling small tetryl pellets become sensitized and develop dermatitis whereas 50 per cent of those working in the tetryl-drying house where they are covered with tetryl dust develop dermatitis

The term hypersensitivity should be used when speaking of primary irritants because everyone is sensitive to them Allergy or specific sensitivity should only be applied to induced or acquired sensitivity which becomes manifest after a period of incubation following initial contact It is present over the entire skin.

A case which may at first appear to be an acquired specific hypersensitivity because it comes on following a definite period after first exposure to a chemical may sometimes on close examination be found not to be due to any specific sensitivity but to altered working conditions which entail more exposure or more physical trauma than usual, or to a greater concentration or greater quantity of the chemical than the worker usually encounters or to temporary alterations in the resistance of the skin such as maceration caused by excessive perspiration or by temporary alterations in the pH of the perspiration which makes for increased absorption of the irritant Such changes in pH may be caused for instance by changes in diet

Thus, many cases of occupational dermatoses seemingly due to allergy can be explained by changes in working conditions or variations from the normal in the skin of the worker or by breaks in the defense mechanism of the skin or as Oppenheim has stated "to the sum total of the mechanical, physical and chemical action of the worker's occupation on his skin"

We have noted instances where there occurred only a few cases of dermatitis among a group of workers and therefore it seemed that these were caused by allergy but upon closer examination it was found that the workers affected were either less cleanly than those who were not affected and therefore had more prolonged contact with the chemicals, or they had breaks in the defense mechanism of their skins which permitted them to have more intimate contact with the chemicals than did the other workers

During the first few years of the existence of the Dermatoses Investigations Section of the U S Public Health Service personal and family histories were taken of allergy in all cases of industrial dermatoses that were seen and the examiners were unable to relate them to any such allergic conditions as hay fever asthma or eruptions of the skin supposedly due to eating foods like strawberries, fish tomatoes etc. No preponderance of such conditions was found in the personal or family histories of those affected with industrial dermatitis as compared with those not affected

The fact that there is a specific hypersensitivity of certain individuals to the action of many substances in industry cannot be denied. Cases have been seen where the mere presence in the same room with dinitrochlorobenzol or with nitrosodimethylaniline has produced pruritus in a hypersensitive individual A case has also been seen of a chemist so sensitive to formaldehyde vapors that when he held his forearm over an open bottle of formalin one could see the erythema develop on the exposed skin in less than a minute That this hypersensitivity can be acquired by continued exposure to certain substances is also a fact. The chemist cited above became hypersensitive after years of exposure. Sensitization may also be induced through channels other than the skin. It may occur through the respiratory or gastro-intestinal tracts, by inhalation or ingestion of a sensitizer

The nitro and nitroso compounds are well known among chemists to be sensitizers. How sensitization to non-protein substances is brought about has been explained by Landsteiner He showed that substances unable by themselves to produce antibodies can do so when linked to a true antigen such as a foreign protein He succeeded in creating a sensitivity to mercury formaldehyde, chrome phenylhydrazene and other substances by combining them with foreign proteins and rubbing them into the broken skin. Parenteral injections of such mixtures gave rise after a latent period to antibodies not only to the protein but also the non-antigenic substances.

Haxthausen also produced skin allergy to mercury chromium and formaldehyde by combining them with horse serum and injecting

them intracutaneously He obtained similar results by combining mercuric chloride with washed cultures of yeast Out of 50 cases studied he obtained positive patch tests with mercury on 4 cases of seborrhea and negative tests in the remaining 46 cases not having seborrhea As a result of these experiments Haxthausen advances the theory that the microorganisms of the skin may play the part of foreign proteins in uniting with the simple chemical compounds to form complex antigens capable of producing antibodies to the simple compounds. Passive transfers in these cases of hypersensitivity to simple compounds have seldom met with success but desensitization to various chemical has been reported by R Cranston Low and by Bloch

When we consider the fact that a large majority of the cases of occupational dermatitis are caused by substances such as alkalis acid corrosive salts fat solvents, and dehydrators, we realize that only a small percentage are due to allergy This is not the case however among wearers and users of finished products Here allergy is the most frequent cause of dermatitis as shown by the fact that the finished products are harmless to the vast majority of the population Furs dyes, cosmetics etc while worn and used by millions cause dermatitis in only a few individuals. We have also occasionally found when patch tests were performed with fur dyes leather dyes, and hair dyes on individuals suffering from allergic dermatitis due to their use that the positive reactions to the patch tests increased in intensity after first appearance became eczematized and persisted for many days or even weeks. The reactions often spread diffusely from the site of the patch and sometimes appeared on distant parts of the body or even became generalized producing elevation of temperature and other constitutional symptoms In cases of industrial origin by far the largest number of patch tests caused local reactions only and did not persist as long

In a compilation of about 10 000 cases of occupational dermatoses made from the reports of various state compensation boards prior to 1939 it was found that about 80 per cent of them were caused by primary irritants and by secondary infections. Allergenic substances like plants dyes rubber etc caused about 20 per cent

Table 3 *is a compilation of about 10 000 cases of occupational* dermatoses made from the reports of state compensation boards prior to 1939

The groups of causative agents marked * among which we must look for allergic occupational dermatoses comprise only about 21 per cent of all the cases However all the cases listed under these groups are not of allergic origin because many of these substances are primary skin irritants as for instance the essential oils of many plants and many dye intermediates. Many of the cases of dermatitis occurring among the fruit and vegetable canners which are classified under plants may be caused by the maceration of the skin with irritant fruit and vegetable juices and subsequent infection and not by allergy But many of the primary skin irritants

are also sensitizers For instance we have seen high degrees of sensitization resulting in allergic occupational dermatoses among workers exposed to such primary irritants as alkalis, formaldehyde phenols limonene (which is the chief irritant in the essential oils of citrus fruits) synthetic insecticides and the salts of chromium and mercury Therefore, we can roughly assume that the percentage of allergic occupational dermatoses caused by primary skin irritants makes up for whatever cases of non-allergic dermatoses are caused by the allergenic substances.

TABLE 3

	Per cent
Petroleum products and greases cutting	11.7
Plants	10.7
Alkalis and their compounds	10.3
Solvents (and other mineral oils)	9.3
Metals and metal plating	8
Chromates and chromic acid	5.3
Dusts	4.8
Dyes and dye intermediates (fur dyes not included)	4.3
Chemical, unspecified	4.2
Acid and acid fumes	3.4
Rubber and its compounds	2.8
Building cement and concrete	2.6
Paints, enamels and varnishes	2.3
Resins	1.8
Burns and physical agents	1.6
Biologic agents	1.3
Cyanides	1.1
Coal tar products	1.1
Desiccators	0.8
Non-metallic elements	0.6
Oils, vegetable (oils, fats and waxes)	0.4
Halogens and their derivatives	0.3
Miscellaneous	1.3
Unknown	9.8

Considered from a standpoint of occupation rather than from that of causative agents, occupational allergic dermatitis is often seen among chemists and laboratory workers Photographers who handle developers, many of which are sensitizers field workers coming in contact with plants florists, fruit and vegetable handlers cannery workers insecticide makers rubber compounders munition workers and dye manufacturers coming in contact with dye intermediates are the occupations among which we are apt to find most of our cases of allergic occupational dermatitis. We have noted that in most instances an allergic dermatitis develops in new workers about one week after they begin work. In many industries where the worker comes in contact with sensitizers, it is a well known fact that the new worker may develop a dermatitis. In most cases however if such a worker is able to keep on working the dermatitis clears up after a period of time The workers call it becoming hardened " In other words exposure first causes a hypersensitization then further exposure causes a dermatitis, and still further exposure causes hyposensitization This shows that desensitization as well as sensitization can occur in industry Therefore, new workers who develop dermatitis should not be taken off the job

but should be supplied with protective clothing and mild medicaments and allowed to continue at their work in order to give them time to develop an immunity to the degree of their exposure. An immunity so developed is only to the degree of the exposure but lasts for a considerable time after contact with the irritant as for instance it lasts over the week end it lasts after the factory has shut down for a week however If the worker stays away from work for a month or more it diminishes so that if he resumes work after a long lay-off he may again have to go through the "hardening" process. Workers who develop such a severe dermatitis that they must lay off from work in order to recover may not develop an immunity and it may be necessary to transfer them to other occupations. There are instances in industry where a worker has worked for many years at a certain occupation before he develops an allergic dermatitis. In such cases we have not known immunity to develop upon further exposure. Such skilled workers to whom a change of occupation means a large financial loss should be given a chance to become *immunized by desensitizing injections before they* are made to change their occupations Attempts to desensitize by injecting minute increasing doses of the sensitizing agent have met with success in only a few isolated recorded cases. In view of the work of Landsteiner Haxthausen and others it is suggested that there is a possibility of obtaining better results by injecting minute increasing doses of the sensitizer mixed with a protein such as egg albumen fungus extracts or the serum of the patient

ACTUAL CAUSES OF OCCUPATIONAL DERMATITIS

The agents that have been found to produce dermatoses in occupation may be divided into five main groups as follows

I **Mechanical**
- Friction
- Pressure
- Trauma

II **Physical**
- Heat
- Cold
- Water
- Electricity
- Sunlight
- Roentgen ray and Radium

III **Chemical**
- Inorganic
- Organic

IV **Plant Poisons**

V **Biological**
- Bacteria
- Fungi
- Animal parasites

In different occupations one or more of these causes are found to predominate but any or all may be present The farm laborer for example is more exposed to heat cold and the actinic rays of the sun than the miner but he is also subject to traumatic injuries, fungous infections, animal parasites chemical irritants in fertilizers and insecticides and to plant poisons.

Mechanical Agents.—Mechanical agents give rise to callosities hygromata, tenosynovitis cuts and abrasions. Wounds of the skin readily become infected with bacteria and fungi and can also become the site of malignant growths or new areas of psoriasis, lichen planus, and similar skin diseases already present on other parts of the body.

Physical Agents.—Physical agents act on the skin in various ways. High temperatures cause perspiration, softening of the horny layers of the skin, and combined with friction produce intertrigo and the so-called "heat rashes" common among workers exposed to hot ovens such as stokers and steel makers. Exposure to heat may also produce dermatitis with slight scaling and venectasia or erythema *ab igne*.

Hot Water.—Hot water softens the epithelium and renders the skin vulnerable to the action of substances such as mild alkalis that would not otherwise affect it. Dishwashing and laundry work are examples of occupations in which maceration of the skin in hot water helps to cause dermatitis.

Cold.—Cold especially when accompanied by dampness produces pernio frost-bite, and in some hypersensitive individuals urticarial lesions have been known to develop from this cause.

Electricity.—Electricity causes occupational burns from short circuits, live wires, and bare wires among linesmen and others engaged in electric power production.

Radium and Roentgen-ray.—Radium and roentgen-ray dermatitis burns, and cancers are occupational diseases to which radiologists and technicians are subject. The use of X-ray in the detection of flaws in metals opens up a new industrial hazard. The industrial use of radioactive substances such as radium radiothorium mesothorium and uranium exposes workers to the action of these rays which can cause burns and cancer. They can cause dermatitis on the hands and arms loss of nails, and ulceration leading to cancer. The principal workers exposed are X-ray machine makers roentgenologists radiologists, radium miners, uranium workers painters of luminous dials, dentists and physicians.

Ultra violet rays are industrial hazards among electric welders where they cause eye flashes, and flash burns of the skin. Prolonged exposure to solar radiation such as occurs among farmers, sailors, and others engaged in outdoor occupations, produces melanosis and proliferative changes in the skin which in some instances become epitheliomatous in character. Solar radiation especially at the seashore and in high altitudes causes inflammation of the skin resulting in sunburn that may become sufficiently severe to incapacitate photosensitive persons. Blondes are more susceptible to severe sunburn than brunettes, but brunettes and even negroes can become photosensitized if they come in contact with photosensitizing substances such as coal tar eosin, pitch asphalt certain petroleum oils and photosensitizing plants such as certain grasses, figs, and those containing oil of bergamot.

but should be supplied with protective clothing and mild medicaments and allowed to continue at their work in order to give them time to develop an immunity to the degree of their exposure. An immunity so developed is only to the degree of the exposure but lasts for a considerable time after contact with the irritant, as for instance it lasts over the week end; it lasts after the factory has shut down for a week; however, if the worker stays away from work for a month or more, it diminishes so that if he resumes work after a long lay-off he may again have to go through the "hardening" process. Workers who develop such a severe dermatitis that they must lay off from work in order to recover may not develop an immunity and it may be necessary to transfer them to other occupations. There are instances in industry where a worker has worked for many years at a certain occupation before he develops an allergic dermatitis. In such cases we have not known immunity to develop upon further exposure. Such skilled workers to whom a change of occupation means a large financial loss should be given a chance to become immunized by desensitizing injections before they are made to change their occupations. Attempts to desensitize by injecting minute increasing doses of the sensitizing agent have met with success in only a few isolated recorded cases. In view of the work of Landsteiner, Haxthausen and others, it is suggested that there is a possibility of obtaining better results by injecting minute increasing doses of the sensitizer mixed with a protein such as egg albumen, fungus extracts, or the serum of the patient.

ACTUAL CAUSES OF OCCUPATIONAL DERMATITIS

The agents that have been found to produce dermatoses in occupation may be divided into five main groups as follows:

- I. **Mechanical**
  - Friction
  - Pressure
  - Trauma
- II. **Physical**
  - Heat
  - Cold
  - *Water*
  - Electricity
  - Sunlight
  - Roentgen-ray and Radium
- III. **Chemical**
  - Inorganic
  - Organic
- IV. **Plant Poisons**
- V. **Biological**
  - Bacteria
  - Fungi
  - *Animal parasites*

In different occupations one or more of these causes are found to predominate, but any or all may be present. The farm laborer, for example, is more exposed to heat, cold, and the actinic rays of the sun than the miner, but he is also subject to traumatic injuries, fungous infections, animal parasites, chemical irritants in fertilizers and insecticides, and to plant poisons.

3 *Irritant Elements and Salts*
- Antimony and salts
- Arsenic and salts
- Chromium and alkaline chromates
- Copper sulfate, copper cyanide
- Mercuric salts
- Zinc chloride
- Silver nitrate
- Elements sodium, potassium and phosphorus burn the skin

PRINCIPAL PRIMARY IRRITANTS

ORGANIC

1 *Organic Acids and Anhydrides*
- Acetic, anhydride, chloracetic (mono di tri)
- Anisic
- Carbolic
- Cresylic
- Formic
- Amino naphthol sulfonic acids (F III J Koch s, Laurent s)
- Lactic
- Maleic
- Metanilic
- Oxalic
- Salicylic

2. *Organic Alkalis*
- Ethanolamines
- Methylamines

3 *Organic Solvents*
- Petroleum solvents
- Coal tar solvents
- Chlorinated hydrocarbon solvents
- Esters
- Ketones
- Turpentine
- Terpenes
- Carbon bisulfide
- Alcohols

4 *Essential Oils*

5 *Acne Producers*
- Petroleum oils
- Cutting oils
- Pitch
- Tar
- Paraffin (impure)
- Solid chloronaphthalenes
- Solid chlorobenzols
- Solid chlorodiphenyls
- Chlordiphenyl oxides
- Solid chlorophenols

Sensitizers or Allergenic Chemicals

Under ordinary circumstances these substances only affect a small percentage of people exposed to them but under extraordinary circumstances such as massive exposure for a long time a much larger percentage will become sensitized A few of these substances by sufficient exposure can produce sensitization in everyone.

The tendency to hypersensitivity may be inherited it may be due to a defect in the defense mechanism of the skin as for instance a deficiency in the skin glands causing a dry skin or a pigment deficiency causing hypersensitivity to light or there may be a true allergy caused by exposure to an allergen

The inorganic primary irritants may also sensitize some people so that they develop dermatitis from such low concentrations as will not affect non-sensitive individuals. These substances according to Landsteiner when linked to a true antigen such as a foreign protein may produce antibodies The same is true of the organic primary irritants. Formaldehyde dichromates and phenol are examples of primary irritants which are also sensitizers.

Almost any chemical can be a sensitizer However some chemicals have greater sensitizing powers than others. For instance phenol formaldehyde and the alkaline bichromates have greater sensitizing powers than the synthetic dyes or rubber accelerators. Usually the organic primary irritants have greater sensitizing powers than those organic compounds which are not primary irritants

It has been proposed to work out the sensitizing index of the common chemical sensitizers this to be done by patch testing a large number of subjects and finding out the percentage which are sensitized This would be a tremendous undertaking and would necessitate patch testing with many dilutions of each of the sensitizers in various solvents. The time the patches would remain on their size and site and the amount of the chemical used would all have to be uniform The threshhold concentrations causing sensitivity would vary with the individual subjects. The results obtained would be open to the criticism that all the above variables cannot be properly evaluated especially when the work must be done by a great many dermatologists who may differ in their interpretations of the tests.

It is impossible to give a complete list of chemicals which may sensitize but a list of the principal sensitizers met with in industry is given below

SENSITIZERS

1 *Dye Intermediates*

- Aniline and compounds
- Chlor compounds
- Nitro compounds
- Acridine and compounds
- Naphthalene and compounds
- Benzidine and compounds
- Benzanthrone and compounds
- Naphthylamines

2. *Dyes*

Fur and Hair	Paraphenylendiamine Aniline black Paramido phenol
Leather	Chrysoidine Bismarck brown Nigrosine Amido-azo-toluene Amido-azo-benzene

Fabric
- Crystal and methyl violet
- Malachite green
- Auramine
- Metanil yellow
- Brilliant indigo, 4 G
- Erio black
- Hydron blue
- Indanthrene violet R. R
- Ionamine, A S
- Pyrogene violet brown
- Orange Y
- Safranine
- Sulphanthrene pink
- Rosaniline

3. *Photo Developers*
   - Metol
   - Paraphenylendiamine
   - Hydroquinone
   - Para-amido-phenol
   - Pyrogallol
   - Bichromates
   - Paraformaldehyde
4. *Rubber Accelerators and Anti-oxidants*
   - Hexamethylene tetramine
   - Guanidines
   - Mercapto benzo thiazole
   - Tetramethyl thiuram monosulphide and disulphide
   - Para toluidine
   - Ortho toluidine
   - Tri-ethyl tri-methyl triamine
   - Phenyl beta naphthylamine
   - Monobenzyl ether of hydroquinone (causes leukoderma)
5. *Soaps*
   - Containing excess of free alkali
   - Containing perfumes
   - Containing antiseptics
6. *Insecticides*
   - Creosote
   - Nicotine
   - Tar
   - Pyrethrum
   - Mercury compounds
   - Phenol compounds
   - Petroleum distillates
   - Arsenic compounds
   - Fluorides
   - Lime
   - Rotenone
   - Thiocyanates
7. *Cosmetics*
   - Those containing irritant or photosensitizing dyes, essential oils, perfumes and resins
8. *Oils*
   - Cutting oils (the inhibitor or antiseptic they contain)
   - Coring oils (cellosolves, eugenols)
   - Sulphonated oils
   - Linseed oil
   - Mustard oil
   - Coconut oil
   - Cashew nut oil
   - Tung oil
   - Essential oils of plants and flowers

9 *Resins*

Natural:
- Pine rosin
- Wood rosin
- Burgundy pitch
- Japanese lacquer
- Dammar
- Copal

Synthetic:
- Alkyd
- Vinyl
- Acrylic acid resins
- Phenol formaldehyde
- Urea formaldehyde
- Melamine formaldehyde
- Sulfonamide formaldehyde
- Chloro-naphthalenes
- Chlorobenzols
- Chlorodiphenyl
- Chlorophenols
- Cumaron

10 *Coal Tar and Its Direct Derivatives*

Acridine	Fluorene
Anthracene	Naphthalene
Phenanthrene	Phenol
Carbazole	Cresol
Pyridine	

11 *Explosives*
- Trinitrotoluol (TNT)
- Trinitromethylnitramine (Tetryl)
- Fulminate of mercury
- Hexanitrodiphenylamine
- Dinitrophenol
- Dinitrotoluol
- Lead styphnate
- Ammonium nitrate
- Sodium nitrate
- Potassium nitrate
- Picric acid and picrates
- Sensol

12 *Plasticizers*
- Propylene stearate
- Butyl cellosolve stearate
- Diamyl naphthalene
- Dibutyl tin laurate
- Dioctylphthalate
- Methyl cellosolve oleate
- Methyl phthalylethylglycolate
- Phenylsalicylate
- Stearic acid
- Tricresyl phosphate
- Triphenyl phosphate
- Triglycol di (2, ethyl butyrate)
- Carbon black
- Genoa toner

Plants and Woods.—Many plants, especially those belonging to the Rhus family, irritate so large a percentage of people that they may be classed practically as primary irritants. Indeed Bloch

showed that while only the hypersensitive were irritated by primula obconica it was possible to produce dermatitis in all people if the toxin of the plant was applied in sufficient concentration. The toxic properties of plants vary with the season and the state of their growth Rhus toxicodendron (poison ivy) is more irritating in the late spring and summer when the leaves are green than in the autumn when they begin to change color

Some plants are poisonous only when grown in certain localities. For instance castor beans grown in some places are toxic while those indigenous to other places are harmless. The same is said to be true of the chinawood tree and the cocobolo

Some plants are photosensitizers. Certain grasses, dandelion wild parsnip and trefoil are examples. The juice of figs is also said to be photosensitizing

The following woods, especially when being sandpapered and polished have been found to be poisonous to a considerable percentage of workers. For more detail see Chapter XXXVIII on Plants and Woods.

West Indian Mahogany	Cocobolo
West Indian Boxwood	Silver Fir
West African Boxwood	Silver Spruce
West African Ebony	Cedar
West African Mahogany	Teak
Brazilian Walnut	California Redwood
Spurge	Satinwood
Manchineel (Cuba)	Cocus wood
Rungus wood	

See Chapter XXXVIII on Plants and Woods.

Biological Agents.—Biologic agents often cause or complicate occupational dermatoses. They may be divided as follows

1 *Bacterial Infections*
   - Infected occupational wounds
   - Folliculitis, caused by staphylococci and streptococci
   - Boils, caused by staphylococci and streptococci
   - Anthrax of hide handlers
   - Glanders of cattle handlers
   - Vaccinia of cattle handlers
   - Impetigo of cattle handlers
   - Erysipeloid of animal product handlers
   - Verruca Necrogenica of cadaver handlers
   - Butcher s Pemphigus

2. *Fungi*
   - Monilia (Kitchen workers)
   - Yeasts (Bakers and fruit handlers)
   - Dermatophytes: Animal caretakers; Fur handlers; Hide handlers; Wool sorters; Barbers; Bath attendants
   - Sporotrichosis, Blastomycosis (Horticulturists)

3. *Parasites*

Ground Itch (Uncinariasis) { Miners, Farmers, Laborers

Mange (Acarus Sarcoptes and Demodex) Dog handlers

Grain Itch (Pediculoides) { Wheat handlers, Straw handlers, Linseed handlers, Corn handlers, Handlers of other grains

Carpoglyphus passularum (Dried fruit handlers)

Caterpillar dermatitis, caused by urticating hairs (Horticulturists)

Hog Itch (Ascaris lumbricoides)

(Cheese Mite) Tyroglyphus longior

These various causative factors may be classified by their action on the skin as follows

1 *Keratin Solvents* such as alkalis and soaps.

2. *Fat Solvents* such as turpentine petroleum distillates, and volatile hydrocarbon solvents.

3 *Desiccators or Hygroscopic Agents* which take the water out of the skin such as sulphuric acid powerful alkalis, and calcium oxide

4 *Protein Precipitants* or denaturants such as heavy metal salts, which form albuminates in combining with the skin.

5 *Oxidizers* which by their strong affinity for the hydrogen in water will liberate oxygen Examples are chlorine gas, peroxide of hydrogen chromic acid and its salts.

6 *Hydrolizers* —Some substances tend to hydrolize when coming in contact with the moisture of the skin and thus form irritating compounds. An example of this class is hexamethylenetetramine which on hydrolizing first forms formaldehyde and later goes on to formic acid

7 *Keratogenic Agents* —Certain substances act as stimulants to the keratin-forming cells of the skin and are apt to cause acne-like lesions and new growths. Petroleum coal tar solid chlorinated hydrocarbons, and their products, are examples of this class.

8 *Sensitizers* —There is still another group to which the skin becomes sensitive after exposure for varying lengths of time These substances may be called anaphylactoid in their action The nitro and nitroso compounds and certain plants and fungi belong to this class

9 *Photosensitizers* —Certain chemicals and plants have a photosensitizing effect on the skin. Workers exposed to coal tar petroleum and many of their derivatives are exceedingly susceptible to dermatitis solaris and develop marked melanosis. Photosensitivity has been reported from contact with figs and certain meadow grasses and also from some dyes such as Brom fluorescein and Rhodamine B

SYMPTOMS OF OCCUPATIONAL DERMATOSES

These depend in large measure on the cause and the clinical type of the lesion. In cases caused by concentrated irritants or by hypersensitivity where the onset is sudden the patient first notices itching of the exposed parts. This is followed by an erythema, papules, vesicles, edema, oozing and crusting. The eruption is an acute moist eczema. The inflammation may be arrested at any of these stages. A worker may not develop symptoms for a period of time varying from a few hours to a few days after contact with the offending substances, and in certain cases of hypersensitivity it may take years of contact to become sensitized. It is likely that in such a case an established immunity was broken down.

Some workers develop only a mild dermatitis, are able to continue working, and finally become immune. In others the dermatitis is so severe that they have to stop working. Workers who suffer a severe attack do not as often develop an immunity as those who suffer a mild attack. Immunity if developed generally lasts only a short time from a week to a month after discontinuing work. The worker who, after working without any trouble for many years, suddenly becomes sensitized to materials he formerly handled with impunity and reacts with a severe dermatitis never becomes immune. He has lost his immunity. He may even become polysensitive to many of the ordinary materials of daily life and as a result suffer from chronic incurable eczema. Fortunately this type is rare.

In cases of exposure to mild irritants over long periods of time the early symptoms are not annoying, but consist only of a mild irritation followed by thickening of the skin and loss of elasticity. This later results in cracks and fissures, and the open sores are irritated and kept inflamed by the entrance of more of the causative agent. Ulcers result and these heal only with difficulty while the patient is working. Such cases present the picture of a chronic fissured eczema. Dehydrating agents such as salt, sugar, and low concentrations of lime and formaldehyde may cause such lesions. Such cases are not due to allergy but to an exhaustion of the defense mechanism of the skin.

Substances like mineral oil, grease, paraffin, chlorinated synthetic waxes, and coal tar pitch can not only cause dermatitis but if allowed to stay in contact with the skin for long periods will block the pores, irritate the epithelium of the skin glands, and cause comedones, acnes, and cysts which may become infected and result in folliculitis and boils.

Petroleum, unrefined paraffin, grease, tar, and pitch cause epithelial proliferation which may result in keratosis, papilloma, and epithelioma of the exposed parts. Tar, pitch, soot, and petroleum may also cause scrotal cancers. Exposure for long periods to certain aniline derivatives such as alphanaphthylamine and benzidine may cause papillomata and carcinomata of the bladder.

Arsenic is more likely to produce keratosis of the palms and soles when taken internally than by occupational exposure

Occupational mycotic infections such as ringworm of barbers and mycoses of the hands and nails of vegetable and fruit canners are not infrequent but their appearance does not differ from similar infections of non-industrial origin and it is often difficult to prove occupational origin.

Parasitic diseases induced by acari form only a small group among occupational skin affections. The symptoms do not vary from those found in non-occupational parasitic diseases in any way and they must be identified as occupational by means of other criteria.

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CHAPTER V

DIAGNOSIS OF INDUSTRIAL SKIN DISEASES

It is important to determine whether a dermatitis from which a worker is suffering is of industrial origin (1) because it has a direct bearing on the treatment of the case and on the prevention of its recurrence (2) because of the compensation involved and (3) in order to determine who pays the physician's fee

If it can be determined that the dermatitis is due to exposure to certain occupational skin hazards then the major portion of the treatment consists in preventing further contact with these hazards that is removing the patient from his working environment or providing him with suitable protective clothing In these cases the prevention of the recurrence of the disease consists in preventing contact with the offending material either by methods stated above or by installing proper safety measures such as totally enclosed processes adequate ventilation clean work rooms clean clothing etc.

The compensation laws in many of the states are so worded that if a physician undertakes to treat a worker and he makes a diagnosis that the disease is of industrial origin then his fee is practically taken care of either by the compensation commission or by the insurance carrier But, if after treating the patient the physician should determine that the dermatitis is not of industrial origin the employer or insurance carrier will not pay for the treatment and the physician must look to the patient for his compensation. You can readily see that this has a tendency to make the physician lean toward a diagnosis of industrial dermatitis because very often his chances of being paid a fee by the poor worker is uncertain. It is to the advantage of insurance carriers and compensation boards to devise means to remedy this condition.

There is no one factor upon which a diagnosis of industrial dermatitis can be made In most instances the appearance of the lesions gives no clue to the irritant Especially is this so in the acute and chronic eczematoid types of occupational dermatoses. All of the following factors must be considered and each one forms only a link in the chain of evidence on which a diagnosis of industrial dermatitis should be made

1 **History** —The history of the dermatitis is most important In order for the dermatitis to be considered as of possible occupational origin it must be brought out that such a dermatitis was not present before the patient entered on the occupation. It must also be shown that the dermatitis developed during the period of industrial exposure or after a lapse of a reasonable incubation period since the cessation of exposure This lapse of the incubation period should not be over a week. If the history shows that other workers

similarly employed are similarly affected or that new workers at the process are usually similarly affected then the possibility of a diagnosis of industrial dermatitis is strengthened If the history should disclose the fact that the patient has had similar attacks of dermatitis previous to the present exposure then the possibility of the present attack being due to his occupation is weakened but not necessarily entirely done away with because it may be possible that in his previous employment he may have met with the same irritant or conditions which are now causing his dermatitis. Knowledge by the physician of the working processes in which the patient is engaged and the substances with which he comes in contact is important because this enables him to know whether the worker is exposed to known irritants or to conditions which tend to cause dermatitis For instance if a worker appears with a dermatitis of the hands and forearms and states that he works on a rubber mixing mill then we know that he is exposed to irritant rubber compounds and is more likely to develop an occupational dermatitis than is a rubber worker who handles only cold vulcanized rubber objects. *If the history shows that the dermatitis develops whenever* the worker is at work gets well or improves when he is away from work and again recurs when he returns to work then the history itself establishes a definite cause and relation factor between the occupation and the dermatitis.

2. **Site of Eruption.**—The site of the eruption is also important In examining patients they should be completely divested of clothing This may in many cases reveal areas of dermatitis on portions of the body not complained of by the patient and may give the clue to a proper diagnosis. Occupational dermatitis usually begins on the exposed parts—the hands the fingers and the forearms if the offending material is a solid or a liquid and also on the face and neck if it is a vapor The covered parts of the body may also be affected if fumes or vapors penetrate the clothing or if the clothing is not frequently washed and becomes saturated with irritant chemicals. Thus, dermatitis may occur on the body of the worker handling irritant dusts which penetrate the clothing such as finely powdered rubber compounds or dermatitis may occur on the covered parts of the body when the clothing becomes saturated with petroleum oils and waxes, especially if the worker does not take daily cleansing baths and if he does not change his work clothes daily

Occupational bacillary infections such as erysipeloid of butchers and verruca necrogenica of cadaver handlers also usually occur on the hands. The malignant pustule of anthrax among hide and leather handlers usually occurs on the head face and arms.

Occupational dermatitis is also often found at points of friction on the body The wrist where the ends of the gloves or the sleeves rub the belt line where the belt or the top of the trousers causes friction the ankle at the shoe tops and the neck at the collar line are all sites where friction aids the action of industrial irritants.

Sometimes a dermatitis of undoubted occupational origin may become generalized This occurs when the irritant is one to which the worker has developed a high degree of sensitivity Many substances are known to be sensitizers Nitro nitroso and the chloro compounds are notorious sensitizers. In such instances a primarily localized dermatitis or burn may also sensitize the patient and a few days later a generalized dermatitis may develop

3 **Characteristic Appearance of Lesions.**—An industrial dermatitis of the acute eczematoid type begins as an erythema followed by papules and vesicles and when the vesicles break by an oozing and crusting no matter what irritant is the cause

Occupational mycotic infections such as ringworm among bath attendants, barbers, beauty parlor operators and yeast infections among cannery workers usually occur on the hands, but the appearance is not different from that of ringworm or yeast infections of non-industrial origin

There are however a few classes of industrial irritants which produce more or less characteristic lesions on certain portions of the body Paronychia and onycholysis are common lesions among fruit and vegetable canners The chlorinated naphthalenes and diphenyls produce acne-like lesions on the face and on the parts of the body which come in contact with the work clothes if the work clothes are not frequently washed and changed. Certain tar compounds also cause acne-like lesions on the exposed parts. Oils cause folliculitis and boils especially on the hairy portions of the body Paraffin grease and tar cause keratoses to develop on the hands and forearms and these keratoses occasionally become malignant. However the scrotal cancers reported in England as occurring among mule spinners and chimney sweeps have not been noted in this country Certain hydroscopic chemicals such as sugar salt and lime which remove the water from the skin and solvents such as the petroleum distillates which remove the fat from the skin may over a long period of time cause dry fissured eczemas. Exposure to certain aniline derivatives such as alpha naphthylamine and benzidine, are known to have caused malignant growths. Gehrmann has reported papillomata of the bladder among the workers exposed over long periods of time to such aniline derivatives. Arsenic especially if taken internally has also caused new growths in the form of keratoses and epithelioma, particularly on the palms and soles. Keratotic lesions and excessive pigmentation around the face and the neck may be occupational among workers exposed to the sun such as farmers and sailors.

Occupational dermatitis must be differentiated from such diseases as seborrheic dermatitis, fungus infections, lichen planus, impetigo contagiosa, pityriasis rosea, erythema multiforme drug eruptions, neurodermatitis and dermatitis due to contact with irritants met with outside of the place of occupation The industrial physician or the general practitioner may at times be in doubt about the diagnosis of these conditions in a worker exposed to an occupational

skin hazard especially if he does not strip the patient and examine the entire surface of the skin but to the dermatologist the characteristic location or appearance of seborrheic dermatitis lichen planus impetigo contagiosa and neurodermatitis and the generalized eruptions of pityriasis rosea erythema multiforme and drugs offer no great problem in differential diagnosis from occupational dermatitis. It is true that the presence of these conditions does not rule out the fact that an industrial dermatitis may also be present In fact the presence of certain of these skin diseases often predisposes a worker to an industrial dermatitis. The greatest difficulty in differential diagnosis is presented by dermatitis due to contact with substances met with outside of the place of occupation In these cases the lesions are similar in appearance and site and only the most careful consideration of all the facts can lead to a correct etiology It is here that the patch test is of greatest value

THE PATCH TEST

The patch test is based on the theory that if a dermatitis is caused by hypersensitivity to a certain substance then if that substance is applied to an area of unaffected skin of the susceptible individual and left on for a period of time it will cause an inflammation at the spot where it touches the skin

If the worker is handling known irritants and his fellow workers are also affected the cause is obvious and the patch test is unnecessary but if he is the only one of the group who is affected then he should be patched with the materials with which he comes in contact in the course of his occupation. If he is patched with only one substance then a control patch should be placed on him If he is patched with more than one substance then any negative reaction from one of these substances serves as a control It is also desirable to use as a control one of the workers who has no dermatitis.

The patch test was devised by Jadassohn almost fifty years ago for demonstrating the causes of contact dermatitis. In the United States the test was not widely used in industry nor was its practical value appreciated until attention was called to the prevalence of occupational dermatitis and the chemicals causing it and to the value of the patch test in differentiating between occupational and other sources of contact dermatitis.

The test was first used as a means of determining the actual causative irritant in cases of contact dermatitis. Since dermatitis has on many occasions been found to be caused by irritant chemicals contained in wearing apparel and cosmetics, manufacturers have taken advantage of the patch test to determine the possible skin irritating or sensitizing properties of new products before placing them on sale to the public

Some enthusiasts have even proposed the inclusion of the patch test as part of the preemployment examination with the idea of weeding out those workers who might develop occupational dermat

itis. The fallacy of this proposal lies in the fact that most workers develop occupational dermatitis by contact with a primary irritant or by acquiring an allergy while actually employed. Preemployment patch testing, therefore, could not weed out those who would become sensitized.

It is now universally accepted that the patch test, if properly performed and interpreted, is a valuable diagnostic procedure. Its value in preventing possible outbreaks of dermatitis from the use of materials containing new chemicals before they are put into general use is just becoming recognized.

This study is based on years of experience in investigating outbreaks of dermatitis and in testing chemicals and articles for possible skin-irritating properties. The authors have performed thousands of patch tests and have had the opportunity in many instances to correlate the results of tests with the occurrence of dermatitis when substances tested were put into actual use.

Technique.—Before an attempt is made to describe the methods used for patch testing, clear distinction must be made between substances which are primary skin irritants and those which will be called sensitizers.

Many chemicals which are primary irritants are also sensitizers, for instance, formaldehyde, alkaline bichromates, mercuric salts, phenols, etc.

It is obvious that patch testing with strong concentrations of known primary irritants will result in reactions on any skin. This does not mean that patch tests should not be performed with dilute solutions of chemicals which in strong concentration are primary irritants. There are published lists of concentrations of chemicals which dermatologists have used to determine hypersensitivity; these concentrations, together with the time they are to remain on the skin, are recommended in an attempt to avoid the primary irritant action of the chemical. Reactions to the patch test depend on 4 factors: (1) the sensitivity of the patient, (2) the concentration of the substance used for patch testing, (3) the length of time it is permitted to remain on the skin, and (4) the amount of the substance per area of skin. For example, it is evident that if a given amount of a substance is permitted to contact a given area of skin for a given length of time, one cannot expect as severe a reaction as from twice the amount of substance permitted to contact the same area of skin for the same length of time. Therefore, in performing patch tests, constant amounts of a chemical or substance should be applied to constant areas of the skin for stated periods. Any intensity of the reaction will then depend on the degree of sensitivity of the patient.

According to the records received from state compensation boards, the majority of occupational dermatoses are caused by primary irritants. Only about 20 per cent are caused by substances which do not have a primary irritant action on the skin. These chemicals which are not primary irritants are responsible for the

great majority of cases of contact dermatitis caused by wearing apparel, cosmetics, ornaments, etc. They induce a specific skin allergy and thus cause dermatitis.

The amount of the substance used in the patch test is significant. The greater the amount per unit area of skin and the greater the area of skin covered, the more likely is a positive reaction to occur. The time that the patch is permitted to remain on the skin is also significant. A patch remaining on for seventy-two hours is more likely to produce a reaction than if it remains on for only twenty-four hours. But reactions obtained after five days may be induced sensitivity by the patch. Therefore patches should not remain on the skin for longer than five days if they are for diagnostic purposes. For prophetic purposes they may remain on the skin for much longer periods.

The amount of material per unit area of the skin can be made constant by making a known constant solution of the substance to be used as a patch test, dipping into it a piece of gauze exactly ½ inch square and 4 ply, allowing it to dry and then applying it to the skin. The solvent should always be allowed to evaporate before applying the patch.

The diagnostic patch test consists in applying a small portion of the suspected substance to a site of normal skin of the patient. This is covered with innocuous impermeable material which is then sealed to the skin by adhesive plaster. There have been many modifications proposed in order to overcome certain objections.

The diagnostic patch test is performed in the following manner:

With Liquids.—Saturate a piece of 4-ply gauze 1 inch square and apply it to uninflamed skin on the arm or back. The liquid from the gauze should not be permitted to trickle from the patch site. For insulation a 2-inch square of non-waterproof cellophane is used.* This is sealed to the skin with adhesive plaster about 3-inches square. When smaller pieces of adhesive plaster are used patches are often lost or there is insufficient contact between the test substance and the skin. The reactions which may result from the adhesive plaster are separated from those resulting from the test substance by the uninflamed skin which is in contact only with the cellophane. In performing a number of patch tests, care should be taken to avoid overlapping of adhesive plaster as this will cause intensification of the adhesive plaster reaction.

With Powders.—In performing patch tests with powders the powder is placed on a piece of gauze in order to keep the reaction localized. If the gauze is moistened it holds the powder better than when dry.

With Solids.—When solids insoluble in water are used, it has been found best to dissolve them in a solvent, making a saturated solution, and wetting a piece of gauze with this solution. The gauze is

* Cellophane is the name applied to glycerine plasticized regenerated cellulose. Only one case of sensitivity to non-waterproof cellophane was seen by the authors during fifteen years of patch testing and applying more than 100,000 patches.

then allowed to dry before being placed on the skin in order to eliminate the action of the solvent. This procedure deposits the precipitated finely divided substance on the gauze and brings about better contact with the skin.

When the insoluble solid is of a resinous character the solution may be painted directly on the skin the solvent allowed to evaporate, and the cellophane and adhesive plaster applied. If the resin adheres firmly to the skin, it is not necessary to cover it with the cellophane and adhesive.

With Ointments.—The technique of testing with ointments is the same as with liquids.

While solvents are primary skin irritants they sometimes also act as sensitizers. When it is desired to determine whether a solvent is causing dermatitis by its action as a sensitizer patch tests may be performed as follows Mix equal parts of the solvent and a bland oil such as liquid petrolatum or corn oil in order to buffer the fat solvent action of the solvent, and patch as for liquids.

It is usually sufficient to leave the patch on for twenty-four hours but sometimes when patching with low concentrations or with weak sensitizers it may be necessary to leave the patch on for three or four days, but not for more than five days as the patient may by that time become sensitized to the patch itself This is especially true of fabrics which contain no strong irritants and to which most people do not react. The reactions should be read not only upon the removal of the patches but every day for at least five days thereafter This is of special importance in testing fabrics. A late reaction indicates a lesser degree of sensitivity than an early reaction.

Modification of the Patch Test.—Rokstad has suggested a modification of the patch test for testing the primary irritant effect of volatile substances. A celluloid chamber is fixed to the skin with adhesive tape or in the case of sensitivity to adhesive, with a paste made of 15 gm. zinc oxide 15 gm gelatin 25 gm. glycerin and 45 cc. distilled water The irritant solvent to be tested is placed on the skin and covered with the chamber When applied correctly the chamber should be airtight and a papule formed by the underlying skin protruding into the chamber The edematous papule which is thus formed facilitates absorption of the test substance

Grolnick advocated the use of non-moisture proof cellophane held in place by collodion in order to avoid a possible adhesive tape reaction.

The so-called window patch test was suggested by Guild in 1939 so that constant observation could be made and a controlled alkalinity or acidity could be maintained A microscopic slide is cut into 1 inch squares the edges are made smooth, and the glass square is fixed to the skin by adhesive on three sides. The substance to be tested is introduced at the open end and then it too can be closed off

Wedroff has suggested that primary irritants containing volatile solvents as diluents should be painted directly on the skin or various concentrations in alcohol can be placed dropwise on the skin and left uncovered.

Sulzberger as well as others, has advocated Scotch cellulose tape as a covering to increase the visibility

It is often advisable to use a so-called artificial perspiration to moisten the test substance because the pH of the perspiration especially in such areas as the axilla may play a role in the solubility of the irritant under investigation The pH of axillary sweat is usually on the alkaline side and that on the body proper is on the acid side pH can vary from 5 to about 8. To approximate the pH of the perspiration acidify the liquid used for moistening with dilute acetic acid or alkalinize with dilute ammonia

Interpretation and Reading of Patch Tests.—It requires considerable experience to interpret correctly reactions to patch tests. It is of practical importance to have a common basis for grading reactions. If the relative sensitivity of a worker to the chemical causing the dermatitis could be clearly indicated by the report of the patch test reaction it could be determined by repeated patch tests whether an employee is becoming more or less sensitive in cases where there is continued contact with the sensitizing chemical. The authors are convinced that "hardening" or hyposensitization takes place in most workers exposed continually to the offending chemical

Since the patch test was first employed gradations of the reaction have been recorded by the symbols 1+ 2+ 3+ and 4+ By this method an erythema on the area of skin to which the chemical was applied is indicated by 1+ erythema and edema by 2+ an erythema, edema papules, and a few vesicles by 3+ erythema edema, many vesicles and in some cases, ulceration are recorded as a 4+ reaction.

Such a method of recording a positive patch test is useful perhaps in indicating the degree of sensitivity to the specific concentration and amount of the chemical used Additional information can be obtained if patches with differing concentrations are applied The degree of reaction will be greatest at the site of greatest concentration. It is for this reason that weak concentrations of sensitizers must be left on longer and observed for at least five days after the patches are removed A reaction not present when the patch is removed but which becomes manifest less than five days after the patch is applied is considered a delayed reaction. The delayed reaction indicates that a low degree of specific sensitivity is present or that a weak concentration of the sensitizer was used To report a patch test reaction properly there should be given (1) concentration of the chemical tested (2) amount of the chemical used (3) area of skin contacted (4) site of application (5) number of days patch test was left on (6) periods after removal of the patch that the readings were made. In this way a more compre-

hensive appraisal of the reaction in terms of the degree of sensitivity can be made.

The true allergic reaction as a rule increases rather than decreases in intensity for twenty-four to forty-eight hours after the patch test is removed. Reactions of primary irritation with few exceptions tend to subside after the removal of the irritant.

The evaluation of a weakly positive reaction (1+) depends a great deal on the experience of the one making the patch test. In dealing with a fabric or other substance containing a weak concentration of a sensitizer a 1+ or 2+ reaction is very significant. This is especially true in industry where dermatitis may not only be due to contact with the sensitizer in low concentration but there may be the added factor of friction with exposure to large amounts of the chemical which is not present in the patch test.

A positive reaction which cannot be reproduced later with the same technique indicates that at the time the patch test was performed the patient was sensitive to the concentration and quantity of the chemical applied. A 1+ reaction which does not persist for twenty four hours is probably a false positive or is caused by a mild primary irritant.

A negative patch test does not necessarily rule out the test substance as a causative agent. The negative reaction might be due to one of three causes (1) Under the condition of the patch test the actual mechanism which produces the dermatitis is lacking, i. e., patch test does not equal working conditions (2) the patient is no longer sensitive (3) the actual sensitizer was not applied.

Prophetic Patch Test.—The use of the patch test for the purpose of foretelling whether a substance will or will not produce dermatitis is a recent development and may be called the "prophetic patch test." It was introduced by one of the authors to determine possible irritant qualities of new chemicals used in the manufacture of wearing apparel, cosmetics or other articles coming in contact with the skin. The patch test is made on 200 or more individuals in the usual way. Since the chemicals or compounds to be tested are new ones it is presumed that there has been no previous contact with them.

Two series of patch tests are carried out on the same individuals ten to fourteen days apart. The first series of tests would give reactions only with a primary irritant, or with people who have been sensitized by previous contact with the chemical. The second series shows the number sensitized by the first series. Experience has shown that even one positive reaction among the second series may indicate that the test substance is a sensitizer which might lead to outbreaks of dermatitis if allowed to be used by large groups of people.

When and Where to Perform Patch Tests.—The impression seems widespread that patch tests should not be performed while an eruption is still present because a flare-up of the dermatitis might take place. The period most favorable to a positive reaction

is at the time when the dermatitis is still present and active. A relative hyposensitivity may develop when the dermatitis is disappearing or after it has disappeared with the result that the patch test would tend to be negative. Here too experience and judgment are necessary in choosing the proper time for performing the tests. Obviously when dealing with a patient who has a generalized dermatitis it is better either to wait until the eruption has improved or if the test is carried out while the eruption is present to use a low concentration of the suspected chemical.

A generalized eruption following the patch test indicates a high degree of sensitivity. Such eruptions are exceedingly rare. Flare-ups of quiescent eruptions are not uncommon following patch tests. These also indicate high degrees of sensitivity.

In cases of true allergic dermatitis, the skin all over the body is sensitive and patch tests can be applied at any convenient site. The most rapid reaction all other factors being equal will take place on the areas of skin where the keratin is thinnest. The thick keratin layer of the palms and soles not only explains the negative patch test which results at these sites but is the main reason why contact dermatitis is rarely seen in these locations.

Complications of Patch Tests.—Unless inadvertently a patch test is made with a primary irritant even strongly positive reactions do not leave a scar. In the presence of marked hypersensitivity patch testing with a fairly high concentration of the allergen may produce a skin reaction which spreads beyond the area of application of the patch or may even elicit a generalized reaction. This may manifest itself as a flare-up of existing lesions, reappearance of lesions which have already faded or the appearance of a generalized eruption. Such a complication may even occur when a standard concentration of the sensitizing chemical is used for the patch test although this is rare. Toxic symptoms from absorption of the test material are unlikely because of the small amounts of chemical used and the relatively small area of skin through which absorption is possible. However rare instances have been reported and systemic symptoms such as a rise in temperature adenopathy and pain have sometimes occurred after patch testing.

Medico-legal Aspects.—Downing has reported instances of law suits and claims due to harmful effects resulting from the use of patch tests. However if the tests are properly carried out by a qualified physician possessing training and necessary knowledge they should be no more open to criticism and lawsuits than any other diagnostic procedure performed by the physician for diagnostic purposes.

Patch tests are of established value in finding the etiologic agents in dermatitis venenata and dermatitis medicamentosa and are accepted by many insurance companies and compensation boards as necessary steps in establishing a causal relationship.

Patch tests should not be performed with allergens with which the patient has not already come in contact and which he may

encounter later in the course of his daily life because of the possibility of inducing a hypersensitivity (with a resultant dermatitis when he comes in contact with the allergen) They should not be performed as a requisite for employment because they will not find workers who will become sensitized nor do they take into consideration the fact that most of those who become sensitized will also become "hardened" Sulzberger's theory of testing workers with certain allergens in order to find those who are likely to be sensitized has not been tried out. It is theoretically unsound because sensitivities are specific and sensitivity to one substance does not mean that sensitivity will develop to another substance

Provocative Patch Test.—When patch testing with a dilute concentration of allergens such as are found in fabrics the reaction in some cases may be negative even though from the history and by actual exposure the allergen seems to be the precipitating cause If however at the same time the test is performed with the dilute concentration a second patch of a strong concentration is applied positive reactions will develop at both sites if the actual allergen has been used. This phenomenon has been called the "provocative patch test" by the authors.

Patch Test With Various Substances

Fabrics —Though dermatitis from fabrics is usually an allergic contact dermatitis, primary irritants, such as antimildews, impregnated into fabrics have been encountered occasionally The allergen may be the dye (rarely) the fabric itself or the finish containing an antimildew an antiseptic an antiwrinkle or a waterproofing compound

A piece of the fabric about 1 inch square may be left on for two to five days. The reaction should be read up to three days after the removal of the patch. Best results are obtained while the dermatitis is still present. If the result is positive, the substances incorporated in the material can be ascertained from the manufacturer and tests performed with the various chemicals. If this is not possible various steps can be taken to determine to some extent the class of allergens involved

Soak the fabric in warm slightly acid water for twenty-four hours to see if the dye bleeds. If it does, the water extract can be concentrated *in vacuo* and then a patch test can be made with the concentrated dye

To remove the finish soak the fabric in ether for a few hours, allow the ether extract to evaporate on a watch crystal and test with the residue

If possible perform a patch test with the gray goods *i e* cloth before any dye or finish is applied This is important to pick up the rare cases of sensitivity to wool cotton, or silks. At the same time as the patch test for the cloth itself is performed it may be necessary to carry out a provocative test as described above

Furs.—In patch testing with fur the test should be carried out with the hairy side of the fur If it is positive rub the fur vigorously with a piece of gauze and should the gauze become discolored the fur is so-called dirty fur A patch test should then be carried out with the gauze discolored by the dye. While most cases of fur dermatitis are due to dye a dermatitis due to fur itself may be found occasionally

Leather.—Dermatitis among leather workers is rather frequent since many primary irritants are used in processing the leather in the removal of the hair from the hide in the tanning process and in leather dyeing Dermatitis has also been reported frequently from the wearing of leather wristwatch straps, hat bands and gloves. The most frequent causes of dermatitis among the wearers were the dyes and tanning agents. These chemicals may be dissolved out of the leather by water or perspiration and cause dermatitis in sensitive individuals. However the number of individuals affected is small compared to the millions of users.

The first step in carrying out the patch test is to determine whether the leather is real or artificial This can often be determined by tearing the leather To test the leather moisten a piece about ½ inch square with the patient's own perspiration from the axilla or with a solution approximating the sweat in pH and patch test in the usual way A positive patch test indicates a sensitivity to something in the leather

To determine whether the dye is the cause of the dermatitis soak a piece of the suspected material in water having the same pH as perspiration The material is left in the solution for about an hour and if the solution is discolored the dye is said to "bleed Evaporate *in vacuo* and patch test with concentrated dye If this *reaction is negative the previously positive reaction indicates* that there is a sensitivity to the tanning agents or other chemicals, which are not easily dissolved out with water

To test the finishing oils or fats as possible causes of dermatitis, soak the leather in ether for fifteen minutes pour off the ether into a water glass, evaporate to dryness, smear a piece of gauze with the fatty deposit and apply to the skin.

The other chemicals in the leather can be traced by patch testing with the leather in different stages of manufacture

If the leather is artificial the celluloid plasticizer dye or synthetic resin may be dissolved out by a solvent and used for patch tests

Shoes.—In investigating suspected cases of dermatitis due to foot-wear it is useless to patch test with the material on the outside of the shoe It is difficult to conceive how contact between the skin of the foot and the outer surface of the leather could take place through the leather the backing interlining and the stocking Dermatitis from shoe polish can occur on the hands of the boot black but not on the foot of the wearer of the shoes.

The backing in the shoes has in it adhesive antimildews fungi-

cides, and other chemicals which are sensitizers. In investigating a shoe dermatitis patch tests should be made with the backing. In some instances the leather on the inside of the shoe, such as the tongue, the inner sole, and the sock lining, may be the cause of the dermatitis, but not the outside leather. The material which causes the dermatitis must get through the sock or the stocking. Therefore, it is worth while to patch test with the sock or stocking (before washing) which should contain the eliciting agent.

Rubber.—Dermatitis due to natural rubber is more frequent among those coming in contact with Pará rubber than those working with sheet rubber, because in the process of coagulating and curing the latex there are more of the products of combustion in the former. Crepe rubber is not smoked and causes very little dermatitis.

Rubber must be vulcanized or cured to make it serviceable. Various chemicals are used in this process. In order to accelerate the vulcanization, chemicals called accelerators are used. There are also incorporated chemicals known as antioxidants to prevent decomposition or oxidation of the rubber. It is the antioxidants and accelerators which are the chief causes of dermatitis. To determine the actual cause of dermatitis due to rubber, patch tests should be done with rubber, the antioxidants, accelerators, and other compounds.

In patch testing with sponge rubber, care must be taken to test with both the spongy and smooth surfaces, as in many instances there are differences in reactions obtained from these surfaces.

The dermatitis due to dress shields is often caused by the rubber which they contain; the active irritant is usually the chemical formed on the surface as a result of the acid or vapor cure.

Cosmetics.—Before placing a new formula on the market, closed patch tests should be performed by a competent dermatologist on at least 200 subjects with the new formula, using as a control an old formula which has been on the market for years and which has caused no unusual number of complaints. The closed patches should remain on for forty-eight hours, after which the reactions should be read each day for three days in order to observe late reactions. The number of reactions obtained from the new formula should not exceed the number obtained from the old.

Ten days after the last reading of the reactions new closed patches of both new and old formulas should be applied on the same 200 subjects and allowed to remain for forty-eight hours, and the reactions again read each day for three days after removal of the patches. If the number of subjects showing sensitization reactions from the new formula exceeds the number showing sensitization reactions from the old formula, the formula is unsafe. These tests will give an idea of the relative skin-irritating and sensitizing properties of the new formulas as compared with the old one but do not give an accurate idea of what may happen

under conditions of actual use. Therefore the following additional tests should be performed.

The same 200 people should actually use the old and the new cosmetics each day on opposite sides of the body for a period of four weeks. If no cases of dermatitis result from the new formula it is safe to place on trial sale. If only one case results, then another group of 200 people should be subjected to the actual-use test. If no cases of dermatitis result among these it is safe to place the cosmetic on trial sale. If more than one case of dermatitis occurs among the first 200 subjects after four weeks of actual use the cosmetic is unsafe.

By trial sale is meant the sale for a period of not less than one month (if no cases of dermatitis are reported before this time) in only one community where between 5 000 and 10 000 packages of the cosmetic are to be sold. If no cases of dermatitis are reported during the trial sale then the cosmetic is safe. If cases are reported during the trial sale the manufacturer should employ a competent dermatologist to investigate and determine the actual cause. The continued sale of the cosmetic or its withdrawal from the market should depend on such an investigation.

In trying to ascertain whether a cosmetic is the cause of dermatitis, it is better to apply the cosmetic daily to the same test site of skin for at least four days in the manner in which the cosmetic is actually used rather than in the form of a patch test. This is because cosmetics when used are not covered and usually a large part of the substance disappears from the skin by evaporation. Covered patch tests do not permit such evaporation and many cosmetics which are harmless in actual use may give positive patch tests when applied in the form of a covered patch.

In performing patch tests with cosmetics which may contain photo-sensitizing materials such as lipstick and dyes, the test should be performed on uncovered portions of the body such as the wrist, the V of the neck, etc. because the photo-sensitization is only manifest on parts which are exposed to light.

Patch tests properly performed and evaluated can be of great help in the diagnosis of industrial dermatitis, but if improperly performed and evaluated they may lead to confusing and unjust conclusions.

FUNGUS INFECTIONS

Fungus infections also offer a problem in differential diagnosis from industrial dermatitis. A large percentage of workers are affected with mycotic infections in some form or other. Epidermophytosis, trichophytosis, tinea cruris and tinea versicolor are common skin diseases. Allergic reactions in the form of dermatoses on distant parts of the body resulting from these fungus infections are recognized by allergists and dermatologists. These allergic reactions or phytids may be confused with industrial dermatitis.

The clinical manifestations of the microbids depends on a develop-

ment of an acquired hypersensitivity to the microörganisms and their products after the primary infection has existed for some time. The incubation period for the development of this hypersensitivity depends on the microörganisms to some extent, on individual predisposition as well as many other factors which cause more intimate contact between the living cells of the skin. Here we see a parallelism between the development of hypersensitivity to industrial sensitizers where secondary factors such as friction, irritants, *et cetera* all play a role as contributory factors to the development of hypersensitivity.

In the group of microbids we have the tuberculids when the causative organism is the tubercule bacillus, trichophytids when a trichophyton fungus is the cause of the primary lesion, epidermophytids when an epidermophyton is the causative organism, and levurids when monilia cause the primary infection. Trichophytid is the general term which has been applied to the microbids associated with fungus infections. The term in the literature has often been shortened to "ids."

While trichophytids are seen with many types of primary fungus infections, as far as industry is concerned the most frequent type of these secondary allergic manifestations to the fungi which comes into question is the presence of an epidermophytid on the hands secondary to epidermophytosis on the feet, which is commonly known as "athletes foot."

The fungi responsible for dermatophytosis of the feet, as far as the temperate zones are concerned, are the simple species known as *Trichophyton mentagrophytes* (*T. gypseum, T. interdigitale, T. pedis, T. niveum, et cetera*). This organism is important because it has acquired a high sensitizing power. The trichophyton fungus grows in the non-living layers of the skin and its appendages. It has never been proved capable of living in actual living cells. This is important to bear in mind because inflammatory reactions do not develop unless actual living structures are invaded. When living structures are invaded by the fungi or their products, sensitization develops.

In experimental reproduction of the syndrome of dermatophytosis of the feet in humans, it was shown that an allergy can develop as quickly as thirteen days after the primary infection. In some individuals a hypersensitivity to fungi may develop months or even years after the primary fungus infection has taken hold. Trauma, treatment with strong ointments, continuous maceration and other types of local irritation probably hasten the development of this hypersensitivity in many instances.

Demonstration of this hypersensitivity can be shown by means of the trichophytin test. This is an extract of fungi which has been used both for diagnosis and treatment.

The fungi of both the epidermophyton, trichophyton, as well as other groups of fungi, contain a general common sensitizing factor so that a patient infected with the trichophyton or a member of

any of the other groups of fungi in whom a hypersensitivity has developed will show a positive reaction to a trichophytin test with an extract made from any of these organisms. It is rare that we meet with a fungus infection where a hypersensitivity has developed to a specific excitant. This accounts for the rare case of trichophytid in whom a trichophytin test is negative For practical purposes however this occasional negative test is so infrequently encountered that it can be disregarded Since it is absolutely essential that a hypersensitivity to the fungi and their products must be present before we have trichophytids, and since this sensitivity is demonstrable by means of the trichophytin test before a diagnosis of trichophytids is made the sensitivity should be demonstrated by means of positive trichophytin reaction.

There are a number of such fungus extracts on the market and they must be properly used and evaluated before the reaction which they produce in hypersensitive individuals can be interpreted intelligently The commercial extracts are usually prepared in 1–30 dilution and it is important to make a control injection with the proper dilution of the nutrient media (Sabouraud s bouillon) to avoid false positive reactions. The test is made by the injection of 1/10 of a cc. of the trichophytin intradermally and the reaction is read in forty-eight hours. Delayed reactions sometimes appear as long as a week after the test is made

We must understand from the beginning that a positive trichophytin reaction means that a patient has once been infected with fungi and does not necessarily mean that an active fungus infection is present at the time the test is read however the absence of a positive trichophytin reaction rules out the presence of trichophytid

Some authors maintain that the incidence of epidermophytosis is so high and so many have already become sensitive that analogous to the incidence of positive tuberculin tests the trichophytin test is so often positive that it is of little practical importance as a means of differential diagnosis. This is a misconception. The test has a high incidence of positivity only in the presence of trichophytids. In a recent study carried out where many hundreds of patients were tested only 50 per cent were positive Other observers such as Lewis and Hopper have also concurred in such observations.

The test manifests itself depending on the degree of hyper sensitivity as an area of redness in those moderately sensitive, as edema, papules and vesicle formation in those more sensitive and in a few rare instances with a lighting up of the ids present or even the appearance of new ids in extremely sensitive patients. The local reaction may vary from one centimeter to three or four centimeters in diameter depending on the degree of sensitivity Methods of grading the reaction from 1 to 4+ have been described

The pathogenesis of trichophytids is about as follows a focus of fungus infection takes place and after an interval of time which may be several weeks, months or years, hypersensitivity develops. The living fungi or their products find their way into the circulating

blood and are disseminated. Actual blood cultures for fungi have been demonstrated. When they come in contact with the sensitized tissue which in this case happens to be the skin they give rise to an inflammatory reaction known as the trichophytids In the case of the living fungi this sometimes gives rise to new foci of infection. This, however is rare Once sensitivity has developed new foci of fungus infections which may arise in other parts of the body by contact, or even those already present as on the feet become more inflammatory due to the local reaction between the fungi and their products and the sensitized living cells.

Criteria have been laid down for a diagnosis of trichophytids which are absolutely diagnostic but of course it is not possible to carry out all of the criteria and in the differential diagnosis of trichophytids from other types of skin eruptions only a few of the criteria need be established The complete criteria are as follows

1 The causative organism must be demonstrated in what is recognized by every one as a classical manifestation of the disease
2. While it is not absolutely essential the organism which is cultured from the primary lesion should be pathogenic.
3 A positive reaction analogous to a tuberculin or a trichophytin reaction must be present.
4. What is considered to be microbid should be seen as frequent accompaniment of the primary lesion
5. Positive blood cultures for the same organism isolated from the primary lesion must be obtained since it is admitted that most of the microbids are hematogenous eruptions. This is necessary because there is no reliable method of demonstrating the presence of circulating toxins.
6 The microbids must develop subsequent to the primary infection.
7 The microbids must usually be sterile
8 A support for the conception of a skin eruption as an id lies in certain clinical characteristics
   (*a*) Appearance of the ids" in showers.
   (*b*) Tendency to symmetry in distribution because of hematogenous origin
   (*c*) Tendency to spontaneous involution after healing of the primary focus.
   (*d*) Focal reactions after injection of sufficient amounts of microbidin (trichophytin)

Varieties of Trichophytids.—Different fungi can elicit the same clinical picture and totally different clinical manifestations can be found associated with the same fungus. However in a majority of instances various types of trichophytids have been found commonly associated with certain of the primary fungus infections. Thus, the inflammatory fungus diseases known as Celsus kerion which is found on the scalp is commonly accompanied by a generalized eruption on the trunk known as lichen trichophyticus, while epi-

dermophytosis of the feet is usually accompanied with a vesicular eruption of the hands. In order to understand the types of trichophytids which may develop we must bear in mind that the localization of the embolized fungi or the greatest concentration of the products of the fungi and the site of the greatest skin sensitivity play an important rôle in the morphology of the resulting trichophytid. As the organisms and/or their products become localized in the small blood vessels of the subcutis a subcutaneous trichophytid develops (erythema nodosum). As they become localized in the vessels of the hair follicle lichenoid forms result. Since the epidermis is especially sensitized vesicular eruptions or even eczematoid eruptions may appear and a scarlatiniform ids have been described where the organism was flooded with toxin.

Table 4 includes the types of trichophytids which have been described. As mentioned previously the trichophytids associated with fungus infection of the feet are overwhelmingly the vesicular eruptions on the hands. While the types enumerated in Table 4 are possible their occurrence is such a rarity that the burden of proof for their being trichophytids rests on the one making the diagnosis.

TABLE 4.—TYPES OF TRICHOPHYTIDS (Modified After Bloch)

I Epidermal trichophytids (epidermis mainly involved)
  1 Eczematoid (dyshydrotic)
  2 Lichenoid.
  3 Parakeratotic.
  4 Psoriasiform
II Cutaneous trichophytids (papillary body mostly involved)
  1 Diffuse forms
    (a) Scarlatiniform exanthemata and enanthemata.
    (b) Erythroderma
  2 Circumscribed and disseminated forms
    (a) Follicular localizations usually lichenoid
    (b) Not exclusively follicular
      (1) Macular papular and even exudative eruptions
    (c) Erysipeloid
III Subcutaneous trichophytids (nodules found in the hypoderm of the type of erythema nodosum)
  1 Acute resolving form
  2. Destructive chronic form
IV Vascular trichophytids
  1 Migrating phlebitis (venous)
  2. Urticaria (capillary)

From the viewpoint of the industrial physician the differential diagnosis of trichophytids from other industrial dermatoses narrows itself down to the vesicular and eczematoid eruptions on the hands which are the most frequent trichophytids associated with fungi infections of the feet. Trichophytids of the hands are infrequently met with in industry just as they are not common in the general population. For this reason when an eruption of the hands occurs in an industrial worker a contact dermatitis rather than a trichophytid should be thought of first.

The following criteria are practical and should be carried out in the differential diagnosis of contact dermatitis and "ids"

1. The presence of an active fungus infection should be established
2. The trichophytin test must be positive before a diagnosis of "id" is made.
3. The eruption on the hands suspected of being an "id" should not improve after a suitable removal of contact with known or suspected industrial irritants.
4. No improvement should occur when fungus infection on the feet is treated if we are not dealing with "ids."
5. The clinical appearance of the eruption must be borne in mind.
   (a) Trichophytids are more frequently seen on the palms and on the sides of the fingers, flexor portion
   (b) Contact dermatitis is most often seen on the dorsum of the hands.
   (c) Trichophytids are usually symmetrical
6. In spite of the clinical appearance and a positive trichophytin test, patch tests with suspected chemical irritants must be made. If the patch test is positive and the trichophytin test is positive, there may be a combination of an "id" and a contact dermatitis

Chronic eczemas, more or less generalized and of long standing offer very difficult problems in etiology especially when they are complicated by secondary infections. Patch tests are of little value in most of these cases, because polysensitivity is usually present It is impossible to determine whether the dermatitis and polysensitivity was caused by industrial exposure or whether the sensitivity was present before the industrial exposure or whether the dermatitis and sensitivity were caused by exposure to substances encountered outside of the work-room.

Cases sometimes appear before compensation boards claiming compensation for disability due to a dermatitis which the worker claims to have suffered as a result of his occupation but which at the time the case is being heard has disappeared. In these cases, it is also difficult to determine the causative factor If patch tests done at this time are positive they are of great help but if negative they are not, because the patient may have developed an immunity by his recovery

From these facts it can be seen that there is no one characteristic symptom on which a diagnosis of an industrial dermatitis can be made. The worker's occupation the history of his skin eruption its site and morphology and evaluation of the patch tests must all be taken into consideration by a dermatologist familiar with the substances and the processes of the worker's occupation before we can hope to make a true diagnosis as to the etiology of a dermatitis in a worker exposed to an occupational skin hazard

The following is a tabulation of substances used in patch testing

This was taken directly from a list compiled by Adolph Rostenberg Jr and Marion B Sulzberger and published in the Journal of Investigative Dermatology Vol. 2, No 3 June 1939

TABULATION OF SUBSTANCES USED IN PATCH TESTING

Key to abbreviations and symbols

acet. = acetone
alc = alcohol 70 per cent
aq = aqueous
chlor = chloroform
c.o. = castor oil
dext = 15 per cent dextrin solution
Ger = German
o. = olive oil
pdr = powder
pet = petrolatum
prop. = proprietary preparation
sat = saturated
sol. = solution

* Designates that we suspect that the concentration given is too strong for routine testing.

† Designates that our tests with this particular substance have been less than 10 in number

‡ Designates that our tests with this particular substance have been less than 10 in number and that we suspect that the concentration given may be too strong for routine testing

§ Designates that this substance may photosensitize the patch-test area, i.e., after the patch has been removed and upon exposure to light, dermatitis may supervene.

a. Designates that this substance has been known to cause a sensitization of the eczematous type even upon a single application to normal skin.

A number after a substance, e.g., Alizarin Red No. 1034, refers to the color index number for that substance. The names of the dyes are the trade names that we were given; wherever an exact identification was possible we have affixed the Color Index number and the chemical name

The numbers given under the "Classifications and where encountered" column designate the following trades and occupational substances

1 Shoemakers
2 Painters
3 Dyes and dye intermediates
4 Lipstick and cosmetic dyes
5 Printers
6 Cosmetic ingredients
7 Hair dyeing ingredients
8 Artists
9 Insecticides and disinfectants
10 Rubber-accelerators and rubber anti-oxidants
11 Explosives
12 Industrial solvents and vehicles

The letters under column headed "Authority" refer to the sources of information regarding the concentrations given, as follows

A Strength established at the Skin and Cancer Clinic or in our private practice.

B SCHWARTZ, LOUIS Sensitivity to External Irritants in Industry New York State Journal of Med 36 1069 December 15, 1936 and personal communications.

C MAYER, R L Das Gewerbeekzem Julius Springer Berlin, 1931

D URBACH, E Klinik und Therapie der Allergischen Krankheiten, Wilhelm Maudrich Vienna 1935.

E BLUMENTHAL, F and JAFFÉ, K Ekzem und Idiosynkrasie, S Karger Berlin, 1933

F [illegible] F and [illegible] E Die beruflichen Hautkrankheiten, Leopold Voss Leipzig 1935.

		Per cent	Vehicle	Classification and where encountered	Authority
Acetanilid	pdr	as is			A
Acetic acid		3	aq.		C
Acetone		as is		13	A
Acetphenetidine	pdr	as is			A
§Acridine	pdr	pure			B
Alcohol—denatured		as is		2	A
Alcohol U.S.P		70–95		12	A
Aldehyde amines		as is		10	B
Alizarin (1 2 dihydroxy anthraquinone)		pure		3	A
†Alizarin 778		1	alc.		A
Alizarin red 1031	pdr	as is		3	A
Alizarin sulphate		10	aq.		A
Alkaloids—as salts		1	aq		[illegible]
All spice		as is			A
Almond oil		as is		6	A
Alpha naphthylamine		pure		10	[illegible]
Alum		10	aq		A
Aluminum acetate		10	aq		A
Aluminum chloride		3	aq	6	A
Aluminum scrapings		as is			A
Amber—oil of		1	alc.		C
Amido azo benzol		2 10	o.o.		D
Amido azo toluene hydrochloride		1	aq		A
Amidol		5	aq.		B
Amidophenol (ortho, meta or para)		3 10	pet.		B
Amidopyrine		as is			A
Amines		2	pet.		D
Amino azo toluene		2	alc.		A
Amino azo toluene	pdr	as is		3	B
Ammonia		1 2	aq	6 7	A
Ammonium bichromate		0 5	aq		A
Ammonium bichromate		0 5	pet.		A
Ammonium carbonate		15	aq.		A
Ammonium chloride		3	aq		A
Ammonium fluoride		0 5–2	aq.		A
Ammonium nitrate		10	aq		A
Ammonium persulphate		1–5	aq		A
Ammonium sulphate		10	aq		A
Amyl acetat		pure			F
Analgesics		as is			A
Anesthesin		3–5	pet.		A
Aniline		10–25	o.o.		A
Aniline black 570	pd	pure		1 2 5	A
†Aniline brilliant green	pdr	pure		3	A
Aniline dyes (See below under "Dyes")		2	o.o.		C
Aniline dyes		2	pet.		C
Aniline dyes	pdr	pure			A
Anise seed oil		25	o.o.		B
Anthracene		pure		3	B
†Anthralin (1.8 dihydroxyanthranol)		0 1	pet.		A
Anthraquinone blue S.R.—1069 Sodium salt of 1-amino-2-bromo-4-o-sulpho-p-tolylamino anthraquinone		pure		3	A
Anthraquinone-powder		pure		3	B
Anthrarobin		3	pet.		A
Antihidrotics—(prop.) (always perform controls)		as is			A
Antimony chloride		3	aq		A
Antimony oxide (Sb_2O_3, Sb_2O_4, Sb_2O_5)		pure			F
Antipyrine		as is			A
Aqualatum (prop. prep.)		as is			
Aquaphor (prop. prep.)		as is			A
†Aqua Velva		as is			A
Argyrol		10	aq.		A
Arnica—tincture of		20–25	pet.		D

		Per cent	Vehicle	Classification and here encountered	Authority
Arnica—tincture of		20–5	[illegible]		D
Arning tincture—modified (anthrarobin, tumenol, glycerin spirits ether)		as is			A
Aromatic oils		1	al		C
Arsenious trioxide	pdr	pure		9	B
Asphalt (no adhesive covering)		as is			A
Aspirin		as is			A
Atropine sulphate		1	aq		C
Auto lubricating oils		60	o.		A
Auto polishes (controls)		as is			A
Azochloramid		0 2	triacetin		
Bakelite (scrapings)		as is			A
Baking powder		as is			A
Baking soda		as is			C
Balata (rubber)		is			B
Balsam of Peru		10	pet.		A
Banana peel oil		pure			A
Barbiturates		as is			A
Barium hydrat		0 5	aq		A
Barium sulphate		as is			A
Barley oil		pure			A
Bayberry—oil of		25	o.o.		[illegible]
Bayberry—oil of		25	pet.		E
Beef fat oil		pure			A
Beeswax		pure		6	A
†Beet salt		5	aq	2	A
Beetle (prop.)		pure			A
Benzaldehyde		10	aq		D
Benzanthrone		pure		3	B
Benzidine		pure		3	B
Benzine		60	o.o	2 5 12	A
Benzocaine		10	pet.		A
Benzoic ac.		6	pet.	6	A
Benzoic anhydride		[illegible]	aq		F
Benzol		60	o.o		A
Benzoquinone		1	aq		A
Benzoyl amino metoxychlor anthraquinone		2	o		F
Benzyl alcohol		10	pet.		F
Benzyl benzoate		10	aq		F
Benzyl chloride		5	aq		D
Benzyl cinnamate		[illegible]	pet.		[illegible]
Bergamot—oil of		10	pet	6	A
Beta hydroxy anthraquinone		1	alc.		B
Beta naphthol		10	o.o.	3	B
Beta phenylacrylic acid		5	pet		F
Bismarck brown—331		pure		1 4	A
Bismogenol		as is			A
Bismuth, colloidal solution		as is			A
Bismuth, metallic (scrapings)		as is			A
Bismuth oxychloride		5	pet.		A
Bismuth subcitrate		25	pet		A
Bismuth subsalicylat		[illegible]	o.o		A
Black Flag	liquid	25	o.	9	A
Black Flag (prop.)	pdr	as is		9	A
Black Rouge		as is			A
Bleaching powder (always perform controls)		10	aq		C
Bluing		as is			A
Borax		sat. sol.		6 9	A
Boric acid	pdr	pure			A
Boric acid ointment U S P		as is			A
‡Brake fluid (prop.) (controls)		as is			A
Brass—metallic scrapings		as is			A
Brass polish		10	aq		A
Brass weldings—scrapings		as is			A

		Per cent	Vehicle	Classification and where encountered	Authority
Brazil wood (red wood)		is		5	A
†Brilliant cresyl blue BB(L)—877 Amino-diethylamino-methyl-di-phenazoxonium chloride		pure		3	A
Brillo		as is			A
‡Bromo acid 763 (see under dyes)		pure		3 1	A
†Bronze liquid paint		as is			A
Burow's solution		10	aq		A
Butyl acetat		pure			F
Butyl alcohol		pure			C
Butyric acid		1	aq		A
Butesin picrate (prop. ointment)		as is			A
Cade—oil of		5–10	pet		A
†Cadmium orange		pure		9	A
†Cadmium red, deep		pure		8	A
†Cadmium red, light		pure		8	A
Caffeine		1	aq		C
Calcimine		as is			A
Calcium arsenate	pdr	pure		9	B
Calcium carbonate		3	aq		A
Calcium chloride ($Ca(ClO)\cdot 4H_2O$)		2 10	aq		D
*Calcium cyanamide (crude)		10	aq		F
Calcium fluoride		0 5	aq		B
Calcium hydrate		0 125	aq		B
Calcium nitrate		10	aq		A
Calcium oxide		10	aq		A
Calcium phosphate		10	aq		A
Calcium sulphide		1	aq		B
Calomel	pdr	pure			D
Camomile—oil of		25	o.o.		E
Camomile—oil of		25	pet.		E
Camphor	pdr	pure			A
†Camphor Ice (prop.)		as is			A
Camphor—oil of		10	pet		A
†Camphor—spirits of		as is			A
Canada balsam		as is			A
Cantharides—tincture of		1	alc		B
Capsicum—tincture of		1	alc.		B
Caraway seed—oil of		23			F
Caraway seed—oil of		1	alc		B
Carbazole	pdr	pu			B
Carbon		as is			A
Carbon disulphide		60			F
Carbon paper		as is			A
Carbon tetrachloride		pure		1 12	A
Carborundum		as is			A
Cardamon		as is			A
Cassia—oil of		1	alc		A
Catiline (prop.)		as is			A
Cement—control		as is			A
Cerium		pure			B
Charcoal		as is		8	A
Chestnut—extract of		10	aq.	5	B
Chicken fat oil		pure			A
Chloral hydrat		10	aq		A
Chloramine		0 5–1	aq		F
Chlorobenzene		5	o.o.		F
Chlorinated lime		5–10	aq		A
Chlorinated naphthalene		pure			B
Chloroform		40	o.o.		A
Chocolat		as is			A
Chrome-alum		as is			A
Chrome yellow	pdr	pure		2	A
Chromic acid		0 5–1	aq		A
Chromium chloride		2	aq.		A

		Per cent	Vehicle	Classification and where encountered	Authority
Chromium potassium sulphat $K_2SO_4.Cr_2(SO_4)_3.24\ H_2O$		10	aq		F
Chromium sulphate		3	aq		A
Chrysarobin		1–5	pet.		A
Chrysoidin brow	pdr	pure		3	A
Cinnabar		3	pet.		A
Cinnamic acid		5	pet.		F
Cinnamon	pdr	as is			A
Cinnamon—oil of		5	o.o.		A
Cinnamylic acid		5	pet.		F
Citric acid		1	aq		A
Citronella		as is			A
Cleaning fluids—prop. non-inflammable kind		as is			A
Cleaning fluid—prop. inflammable kind (controls)		60	o.o.		A
Clorox—(prop.)		10	aq		A
Clothing and clothing materials		as is			A
Cloves	pdr	as is			A
Cloves—oil of		25	o.		E
Cloves—oil of		1	alc.		C
CN—(prop.)		1 10	aq	9	A
Coal tar—crude		5–10	pet.		A
Cobalt chloride		2	aq	-	A
Cobalt oxide		pure			F
Cocaine		1	aq.		C
Cochineal natural—932		10	aq		A
Cocoa		as is			A
Cocoanut—oil of		pure			A
Cod fish oil		pure			A
Cod liver oil		as is			A
Codeine sulphate		1	aq		A
Coffee		pure			A
Coffee—oil of		pure			A
Collodion		as is			A
Colza oil		as is			D
Copal		pure			A
Copper chloride		1	aq		A
Copper cyanide	pdr	pure		6	B
Copper scrapings		as is			A
Copper sulphate		5	aq	1 5 6 7	A
Coriander—oil of		1	alc		A
Cosmetics (always perform controls with hair tonics, etc.—cuticle softeners, etc., are usually primary irritants)		as is			A
Cotton seed oil		pure			A
Crayons		as is			A
Creosot		10	o.o.		D
Cresol		0 5 1	aq	9	A
Crude oil		as is		2	A
Crystal violet 681 hydrochloride of hexa methylpararosaniline		2	aq	3	A
Cumarone		pure			B
Cutch		pure		5	A
†Cuticle remover (controls)		as is			A
Cyclo hexanol		50	o		F
Dammar		pure			A
Decahydro naphthalene (Dekalin)		50	o.		F
Dekalin (Ger. prop. name for turpentine substitute)		50	o.o.		F
Denatured alcohol (controls)		as is			A
Deodorants		as is			A
Depilatories (always perform controls)		as is			A
Dermatol (Ger. prop. dusting powder)		pure			C
Dextrin		50–60	aq		A

		Per cent	Vehicle	Classification and where encountered	Authority
Di-acetyl-amido-azo-toluol		2	pet.		O
Dianisidine		pure		3	H
Diazonium salts		1	pet.		C
(Sym) Di-beta-naphthyl-paraphenylene-diamine		pure		10	H
a.Di-chlor-benzene		5	chlor		F
Di-chlor-benzidine		5	alc.		F
Dichloronitro benzine		10	aq.		A
1 2-4 dichloro-nitro benzene		1	acet.		A
1-4-2 dichloro-nitro benzene		1	acet.		A
Di-ethylene glycol		10%	aq	12	A
Di-methyl amine		pure		3	B
Di-methyl aniline		10-25	o.o.		C
1 2 di-hydroxy-anthraquinone		0 5	alc.		A
1-8 di-hydroxy-anthraquinone		0 5	alc.		A
1-4 di-hydroxy-anthraquinone		0 5	alc.		A
1-8 di-hydroxyl-anthranol		0 1	pet.		A
a.1 2-4 dinitro-chlor-benzene		1	acet.	3	A
Dinitro cresol		5	chlor		F
2-4 dinitro phenol		10	aq		A
Dinitro toluol		sat.	alc.	11	B
Di-ortho-tolyl guanidine	pdr	pure			B
Di-ortho-tolyl-thio urea	pdr	pure			B
Di-phenyl		pure			B
Di-phenyl guanidine		2-10	o.o.		F
Dithio acids—salts of		pure		10	B
Ditolyl amines		pure		10	B
†Dopa (dioxyphenylalanine)					A
Dragon's blood (prop.)		as is			A
Dust oil		as is			A
Dusts		as is			A
Dutch Cleanser (prop.)		as is			A
Dyes—lakes and toners	pdr	pure			A
I *Dyes***			all the following:		A

**We are indebted to Dr Joseph Goodman of Boston, Mass., for his invaluable assistance in preparing this list of dyes, lakes and toners.

Name	Color Index No.	Chemical name
Guinea Green B	666	Sodium salt of p-sulfo-benzylethyl-amino fuchsonbenzylethyl-iminium sulfonate
Light Green SF Yellowish	670	Disodium salt of p-sulfo-benzyl-ethylamino p sulfo fuchson-benzylethylimonium sulfonate
Fast Green FCF		Disodium salt of 4 hydroxy 2 sulfo 4 /(N ethyl N p sulfobenzyl) amino/ 4 /(N ethyl N p benzylsulfonium)-imino/ triphenylmethane
Naphthol Yellow S	10	Disodium salt of 2 4 dinitro-alpha-naphthol-7-sulfonic acid
Yellow AB	22	Benzene-azo-beta-naphthylamine
Yellow OB	61	o Toluene azo beta-naphthyl-amine
Tartrazine	640	Trisodium salt of 4-p-sulfobenzene-azo 1 p sulfobenzene 5-hydroxy pyrazol 3 carboxylic acid
Sunset Yellow FCF		Disodium salt of p-sulfo-benzene-az -beta naphthol 6-sulfonic acid

Name	Color index No.	Chemical name
Ponceau 3R	80	Disodium salt of pseudo-cumene-azo beta naphthol 3 6 disulfonic acid
Amaranth	184	Trisodium salt of 4 sulfo alpha-naphthalene azo beta naphthol 3 6 disulfonic acid
Erythrosine	773	Disodium salt of hydroxy-tetra-iodo-o-carboxy-phenyl-fluorone
Ponceau SX		Disodium salt of 2-(5-sulfo-2-4-xylylazo) 1 naphthol 4 sulfonic acid
Orange I	150	Sodium salt of p-sulfobenzene-azo-alpha-naphthol
Brilliant Blue FCF		Sodium salt of p-sulfo-benzylethyl-amino-o-sulfo-fuchsin -benzyl-ethylimonium sulfonate
Indigotine	1180	Sodium salt of indigotine 5 5 disulfonic acid
Bromo acid	768	Hydroxy-tetrabromo-o-carboxy phenyl-fluorone
Erythrosine	772	Hydroxy-di-iodo-o-carboxy-phenyl-fluorone

II *Lakes and toners of the following dyes*

Color index No	Chemical name
10	2 4 dinitroalphanaphthol-7-sulfonic acid
35	Benzene azo beta naphthol carboxylic acid
44	Para nitro benzene azo beta naphthol
69	M-nitro-p-toluene azo beta naphthol
151	P-sulfo-benzene-azo-beta naphthol
163	P-toluene-o-sulfonic acid azo beta hydroxynaphthoic acid
165	6 sulpho 4 chloro 3 toluene azo beta naphthol
189	2 naphthalene-1-sulfonic acid azo beta naphthol
190	Naphthalene 1 sulfonic acid azo beta oxynaphthoic acid
216	2 carboxy benzene azo beta naphthol 3 6 disulfonic acid
332	Hydrochloride of toluene sulfonic bis-m-toluylenediamine
640	Sodium salt of 4-p-sulfobenzene azo 1-p-sulfobenzene 5-hydroxy-pyrazol-3-carboxylic acid
655	Hydrochloride of tetramethyldiammo-diphenyl ketonimine
670	P-sulfo-benzylethylamino-p-sulfo-fuchson-benzylethyl-ammonium
671	P-sulpho-benzylethylamino-o-sulpho-fuchson benzylethylammoniumsulfonate
680	Hydrochloride of pentamethyl-triamino-triphenyl carbinol anhydride
49	Tetramethyldiamino-o-carboxy-phenol-xanthenyl chloride
883	Dimethyl-amino-hydroxy-carboxy-diphenazthone
1027	1 2 dihydroxyanthraquinone
None	O-chlor-p-nitro-benzene azo beta naphthol
None	Alpha naphthalene azo beta naphthol
None	Meta toluene sulfonic acid azo beta naphthol
None	Chlor benzene sulfonic acid azo beta oxynaphthoic acid
None	M-nitro-p-toluene-azo-acetanilid
None	Dinitrobenzene-azo-beta naphthol

	Per cent	Vehicle	Classification and here encountered	Authority
Earthy pigments	pure			A
El Kay Insecticides—prop.	50	o.o.	9	A
Elon—fresh (prop.)	0.5	aq		A
Enamel (always perform controls)	as is		4	A
Eosin pdr	as is		4	A
Ephedrine	1	o.o.		A

	Per cent	Vehicle	Classification and here encountered	Authority
Erythrosine 772 partially iodated fluorescein	as is		4	A
Esbach's Reagent	2	aq		C
Essential oils (always perform controls)	1	alc		C
Ester gums	pure			B
Esters	pure			C
†Ether	60	o.o		C
Ethyl acetat	pure			F
Ethyl mercury chloride	0 5	aq	9	B
Ethyl mercury phosphat	0 5	aq	9	B
Ethylene dichloride	50	o.o.	6 12	A
Ethylene dichloride	0 1	alc	6 12	A
Eucalyptus—oil of	1	alc		A
Eye lotions—cosmetics—shadows	as is			A
Fagi—oil of	5	pet		A
Fenchyl alcohol	pure		12	B
Fennel—oil of	1	alc		A
Ferric chloride	2	aq	1	A
Ferric ferrocyanide	as is		4	A
Ferric sesquichloride	10	aq		C
Ferrosulphate	10	aq	5	A
Fertilizers—most commercial preparations (always perform controls)	as is			C
Fixatif	as is		8	A
Flavoring oils (always perform controls)	2	alc.		B
Flit—prop	25	o.o.	9	A
Floor wax (always perform controls)	10	o.o.		A
Floor wax (controls)	50	o.o.		A
Flour—all kinds	as is			A
Flour bleaches (always perform controls)	as is			A
Flowers—fresh, dry artificial (controls)	as is			A
†Fluorene	pure			B
Fluorescein	1	alc.		A
Flux aluminum	as is			A
Flux iron	as is			A
Flycide (prop.)	25	o.o	9	A
Foods—any kind (except rinds of certain fruits, spices, mustard, etc.)	as is			A
Formaldehyde	5	aq	1	A
Formic acid	1	aq		A
Fowler Solution	as is			A
Frostilla (prop.)	as is			A
Fuchsin	10	aq	3	A
Furfural	pure		12	B
Furniture polish (always perform controls)	10	o.o.		A
Furs—any—dyed natural	as is			A
Fustic (yellow wood)	pure		3 5	A
Fustic (yellow wood)	sat.	aq.	3	A
Galalith	as is			A
Gasoline—regular—ethyl	60	o.o.	12	A
Gentian violet (BDC)—680—a mixture of 1 part of dextrin with 1 part of hexa- and penta-methyl pararosaniline hydrochlorides with some tetramethyl pararosaniline hydrochloride	2	aq	3	A
Ginger pdr	pure			A
Ginger—oil of	25	o.o		E
Glue	as is		1	A
Glycerine	pure		6	A
Glycerine oil	as is		2	A
Glyptal (prop.)	pure			B
Gold Dust (prop.)	as is			A
Gold sodium thiosulphate	0 5	aq		A

	Per cent	Vehicle	Classification and where encountered	Authority
Grapefruit peel oil (always perform controls)	pure			A
Graphite	as is			A
Grease solvents—most proprietaries (controls)	as is			A
Greases	as is			A
Guanidines	pure		10	B
Gum arabic	as is			A
Gun grease	as is			C
Gunpowder	as is		11	B
Gutta percha	as is			A
Gutta siak (rubber)	as is			B
Hair—all kinds—natural—dyed	as is			A
Hair dyes	as is		7	A
Hair tonics—lotions (controls)	as is		7	A
Hat—glazing or sizing or lacquers for—(controls)	as is			C
Hempseed oil	as is			A
Henna, Egyptian	as is		7	A
Henna, white	as is		7	A
Hexahydrophenol	50	o		
Hexalin ($C_6H_{11}OH$)	50	o.o.		F
Hexamethylene tetramine	pure		10	B
Histamine (acid phosphate)	0.1	aq		A
Homatropine	1	aq		G
Hydrochloric acid	1	aq		A
Hydrofluoric acid	0.2	aq		E
Hydrogen sulphide	*10*	*aq*		*D*
Hydroquinone	5	aq		A
Hydroterpene	50	.o		F
Hydroxy-mercuri-chlorphenol	0.5	aq	9	B
Hydroxy-mercuri-cresol	0.5	aq	9	B
Hydroxy-mercuri-nitrophenol	0.5	aq	9	B
Hypnotics	as is			A
Ichthyol	5–10	pet		A
Indigo	10	aq	3 7	A
†Indole	sat.	aq		A
Inecto A—prop. hair dye	as is		7	A
Inecto B—prop. hair dye	as is		7	A
Inks	as is			A
Iodine crystals	0.5	pet.		E
Iodine crystals	1	al		E
Iodine—tincture of—U.S.P. (do not cover simply paint on)	as is			A
†Iodobismitol—prop.	as is			A
Iodoform	25	pet.		A
†Iridium chloride	10	aq		A
Iron chloride	2	aq		A
Iron—metallic scrapings	as is			A
Iron sulphate	10	aq	5	A
Istizin—1,8 dihydroxyanthraquinone	*0.5*	alc		A
Javelle Water	10–20	aq		A
J-O Roach Powder—prop. insecticide	as is		9	A
Juniper—oil of	25			[illegible]
Juniper—oil of	1	alc		A
Kainit—(Ger. prop. fertilizer)	10	aq		C
Karbolineum—(Ger. prop. wood preservative)	50			C
Kill It—prop. insecticide	as is		9	A
Kerosine	60		9 12	A
Lac dyes	50	pet		C
Lacquers (controls)	as is		3 8	A
Lakes (See Dyes)	50	o.o		C
†Lakestine pdr	as is			A
Lanolin	as is		6	A

	Per cent	Vehicle	Classification and here encountered	Authority
Lard	as is		6	A
Larvex—prop.	10	o		A
Latex	as is			B
Laurel—oil of	25	o		C
Lavender—oil of	1	alc		A
Lead arsenate	pure		9	B
Lead arsenate	5	aq	9	A
Lead azide	pure		11	B
Lead chloride	pure		5	A
*Lead—red	as is		2 8	A
Lead styphnate	pure		11	B
Lead subacetat	0.2	aq		A
†Lead sulphide	2	aq	7	A
Lead—white	as is		3	A
Leathers—natural—tanned—dyed—imitation	as is			A
Lemon—oil of (controls)	1	alc.		A
Licorice	as is			A
Lime—burnt	10	aq		F
Lime—slaked (controls)	as is			A
Linalool	1	alc.		B
Linseed oil	as is		2 8	A
Lipstick	as is			A
Liquor carbonis detergens	10	pet.		A
Liquor sesquichlorati	10	aq		C
Listerine (prop.)	10	aq		A
Lithol Red 180 as lakes and toners	as is			A
Local anesthetics	as is			A
Logwood	sat.	aq	3 5	A
Lubricating oils (controls)	as is			A
Lugol's Solution—U.S.P	50	aq		A
Luminal—prop.	as is			A
Lysol—prop.	1	aq	9	A
Mace—oil of	1	alc.		A
Machine oil (controls)	50	o.o		A
Manganese oxide	pure			F
Maroon 677 (partly impure magenta)	as is		4	A
Mascara	as is			A
Mastic	pure			A
Mastisol—(Ger. prop. collodion-like substance)	as is			C
Melissa—oil of	1	alc		A
Menthol	1	pet.		A
†Mentholatum—prop.	as is			A
Mercaptans	pure		10	B
Mercurochrome	2	aq		A
Mercury bichloride	0.1	aq	1	A
Mercury fulminate	pure		11	B
Mercury oxycyanate	1 2	aq		B
Mercury white ammoniated	5–10	pet.		A
Mercury—yellow oxide of	5	pet.		A
Merthiolate—tincture of	as is			A
Metals—pure—alloys	as is			A
Metaphen	0.5	alc.		A
Meta-toluylene-diamine	pure		3	B
Methyl acetate	pure			F
Methyl alcohol	pure			O
Methyl aniline	10–25	o.		O
Methyl benzoate	1	aq.		F
Methyl heptin carbonate	0.1	alc.	6	A
Methyl orange 142—sodium salt of p-sulphobenzene-azo-dimethylaniline	5	aq	3	A
Methyl protocatechuic aldehyde	10	pet.		F
s.†Methyl salicylate	2	o.o.		A

	Per cent	Vehicle	Classification and here encountered	Authority
Methyl violet—090— mixture of the hydrochlorides of the more highly methylated pararosanilines containing principally the tetra, penta, and hexamethyl derivatives	2	aq	3	A
Methyl violet—as lake	as is		4	A
Metol (prop.)	5	aq		A
Michler's Hydrol	5	alc	3	B
Mineral colors or pigments	as is			A
Mineral oil	as is			A
Mirbane oil	25	o.o.		I
†Mistol—prop	as is			A
Mono-benzyl-para-amino-phenol	pure		3	B
Mono-chlor-benzene	5	o.o.		F
Morphine	1	aq		O
Moth flakes	as is		9	A
Mouth washes	as is			A
Mucilage	as is			A
Mustard—oil of	1	alc		A
Naftalan (Ger prop)	10	pet		A
Nail polish	as is			A
Naphtha	50	o.o.	12	A
Naphthalene	pure		9	A
2 Naphthalene 1 sulfonic acid azo beta naphthol	as is	pdr	4	A
Naphthalic acid ($C_{12}H_6O_4$)	1 5	aq		F
Naphthenol	50	o o		F
Naphthol yellow	pure		3	A
Naphthylamine	2	alc		B
Neoarsphenamine	1	aq		A
Nickel nitrate	5	aq		A
Nickel sulphate	5–10	aq	1	A
Nicotine salicylate	5	aq	9	A
Nigrosine	pure		3	A
Nile blue	pure		3	A
Nitric acid	2 3	aq		A
Nitrobenzol	10–25			E
Nitrophenol	5	chlor		D
Nitroso-dimethyl aniline	1	alc.	3	B
Novocain	2	aq		A
†Novon (prop)	as is			A
Nupercaine	1	pet.		A
Nutgalls—roasted	as is		5	A
Nutmeg—oil of	25	o.o		B
Nylander Reagent	as is			C
Oakum	as is			A
Oat oil	as is			A
Ochre red	pure		3	A
Oidiomycins (always perform controls)	undil.			A
Oil of bitter almonds	1	alc.		A
Oil paints—in tubes	as is			A
Oil paints—for walls	50	o.o.		C
Olibanum	pure			B
Olive oil	pure			A
Orange—oil of	25	o.		D
Orange—oil of	1	alc		A
Orange II 151 lake	pure		4	A
Orris root pdr	pure		6	A
Orthoform	25	pet.		A
Orthonitranisol	5	aq		F
†Osmic acid	10	aq		A
Oxalic acid	4	aq.	2	A
Paint—house	50			O
†Palladium chloride	10	aq		A
Palm oil	as is			A

	Per cent	Vehicle	Classification and where encountered	Authors
Para-amido-phenol	3	aq	5 7	B
Para-amido-phenol	10	o.o.	5	A
Para-amino-diphenyl amine	3	aq	5	B
Para-amino-phenol	10	pet		[illegible]
Para-di-chromo benzine	10	aq		A
Paraffin	pure		6	A
Para-nitro benzoic acid	pure		3	B
Para-nitro-chlor benzene	10	acet		B
*Para-nitroso-di-methyl aniline	1	acet.	10	A
Para-phenylene-diamine	2	pet.	1 3 5 6 7	A
Para red, deep—44 as lake or toner	as is		3	A
Para red, light—44, as lake or toner	as is		3	A
Pastes	is			A
Peanut oil	as is			[illegible]
Pellidol (di acetyl amido azo toluol) (prop.)	2	pet		C
Peppermint—oil of	25	o.		E
Peppermint—oil of	1	alc		A
Perfume oils (always perform controls)	1	alc		[illegible]
Perfumes (always perform controls)	as is			A
Peroxide—U.S.P	as is		6 7	A
Persil—(Ger prop. cleansing substance)	10	aq		C
Peterman Insecticide (prop.)	25	o.	9	A
Petrolatum—white or yellow	pure			A
Petroleum	20	o.o		A
Phenacetin	as is			A
†Phenanthrene pdr	pure			B
Phenolphthalein—white or yellow pdr	as is			A
Phenolphthalein—white or yellow pd	2	alc		A
Phenyl alpha naphthylamine	pure		3	B
Phenyl beta naphthylamine	pure		10	B
Phenyl glycine	pure		3	B
Phosphorus trisulphide (P_4S_3)	0 5	pet		F
Photographic developers	5	aq		C
Phthalic acid	1-5	aq		F
†Phthalic anhydride	1	alc		A
Picric acid	1-5	pet		A
* Picryl chloride	acet.			A
Pigments—for artists, etc. (See also under heading Dyes and Pigments)	as is			A
Pine oil (controls)	pure		12	A
Pitch (just apply) (no covering)	as is			A
Plant oils—(Lederle commercial preparations for testing)	as made			A
*Plants—fresh—dry—any part of (controls—many plant juices are primary irritants)	as is			A
Plaskon	pure			B
Plaster of Paris	as is			A
Plaster—wall	as is			A
†Platinum chloride	10	aq		A
Poison ivy extract—8 per cent solids	0 1		acet.	A
Polishes—commercial prep.	as is			A
Pontachrome blue black [illegible]—sodium (or zinc) salt of 4-sulpho-2-hydroxy-a-naphthalene-azo-b-naphthol	pure		3	A
Pontacyl black (similar to 316)	pure		3	A
Pontamine diazo black—401—sodium salt of diphenyl-diazo-3 6-disulpho-B-naphthylamine-2-amino-8-naphthol-6-sulphonic acid	pure		3	A
Pontamine black—581—sodium salt of benzene-azo-3 6—disulpho-8-amino-1 naphthol 7-azo-diphenyl-azo-m-phenylene-diamine	pure		3 5	A

6

	Per cent	Vehicle	Classification and [illegible]	Authority
Pontamine blue—406—sodium salt of diphenyl-diazo-bis-8-amino-1-naphthol-3 6-disulphonic acid	pure		3	A
Pontamine fast orange S	pure		3	A
Poppy seed oil	as is			A
Potash	10	aq		F
Potassium acetate	10	aq		A
Potassium bichromate	5–1	aq.		A
Potassium bromate	6	aq		A
Potassium bromide	100	aq		A
Potassium bromide	25	pet		A
Potassium carbonate	3	aq		A
Potassium chlorate	10	aq.		F
Potassium chloride	3–10	aq		A
Potassium chromate	0 5	aq		F
Potassium citrat	10	aq		A
Potassium ferricyanide	10	aq		C
Potassium ferrocyanide	10	aq	6	C
Potassium hydroxide	0 5	aq		A
Potassium iodide	3 6	aq		A
Potassium iodide	25	pet.		A
Potassium nitrate	25	aq		F
Potassium permanganate	1	aq		A
Potassium persulphate (should be freshly made)	2 5	aq		A
†Potassium salicylate	as is			A
Powder—cleansing scouring (controls)	as is			A
Powder—face, bath	as is			A
a.Primrose—expressed juice of fresh plant	25	aq		C
a.Primrose, leaf	as is			
Propylene glycol	10	aq		A
Protein extracts—foods, plants, bacteria	as is			A
Pyridine	30	o.o.		C
Pyrethrum—milled powder	as is		9	A
Pyrethrum—tincture of				
†Pyro	as is			A
Pyrogallol	3	q	5 7	D
Quercitron	pure		5	B
Quinine	1	aq		A
Quinine sulphate	25	pet		A
Quinizarin (1 4 di-hydroxy-anthraquinone)	0 5	alc.		A
Quinosol	2– 5	dext		F
Rapeseed oil	pure			A
Rapidol—(prop)	as is			A
Raw umber	as is		2 6	A
a.Resins (controls—see plants)	as is			A
Resorcin (controls)	3	aq		A
Rhodamine B 749 lakes and toners of	as is		4	A
†Rhodium chloride	[illegible]	aq		A
Rice oil	as is			A
Rockwood	as is			
Rose—oil of	25	pet		B
Rose—oil of	1	al		A
Rosin	as is		7	A
Rubber—rubber products	as is		1	A
Rue—oil of	6	pet.		A
Rye—oil of	pure			A
Safranine O 841—mixture of diamino-phenyl-ditolazonium chloride and diamino-o-tolyl ditolazonium chloride	pure		3	A
Sagrotan—(Ger prop disinfectant	1	aq		C
Sal ammoniac	3	aq	5	A
Salicylic acid	5–10	pet.	6	A
Salol	as is			A

	Per cent	Vehicle	Classification and here encountered	Authority
Salves—prop. (controls)	as is			A
Sangajol—(Ger. prop. name for a turpentine substitute)	30	o.o.		C
Santal—oil of	1	alc		A
Sassafras—oil of	2	o.o		B
Sassafras—oil of	1	1 alc		A
Scalp lotions (controls)	as is			A
Scopolamine	1	aq.		E
Sensol	as is		11	E
Shampoos—(controls)	as is			A
Shellac—(controls)	as is		2 6	A
Shoe dyes (controls)	50	o.o.		A
Shoe polishes (controls)	50	pet		A
Sidol—(Ger. prop. silver polish)	10	aq		D
Silver amalgams	as is			A
Silver metallic—scrapings	as is			A
Silver nitrate	5	aq		A
Silver nucleinate	5	aq.		A
Silver paint	as is		7	A
Simoniz—prop.	as is			A
Skatol	sat	aq		A
Smokeless gunpowder	as is		11	E
Soap—tincture of green	5	pet.		E
Soap—tincture of green	2 5	alc		E
Soaps—(always perform controls)	as is	aq		A
Soaps	1–3	aq		B
Sodium arsenate	10	aq	5 9	A
Sodium benzoate	20	aq.		A
Sodium bicarbonate	5 3	aq		A
Sodium bichromate	3	aq.		A
Sodium bromide	25	pet		A
Sodium carbonate	3 10	aq		A
Sodium chloride	10	aq		A
Sodium fluoride	0 5	aq	9	A
Sodium fluorosilicate	0 5	aq.	9	B
Sodium hydroxide	0 5	aq		A
Sodium hypochlorite	10	aq.		A
Sodium hyposulphat	1	aq		A
Sodium metasilicate	2	aq		B
Sodium oleate	1	aq		B
†Sodium salicylate	1	aq		A
Sodium stearate	1	aq		A
Sodium sulfite	1	aq		A
Sodium sulphate	5	aq		A
Sodium sulphide	2	aq		A
Sodium thiosulphate	5	aq	7	A
Soluble blue—325	pure		3	A
Spearmint—oil of	1	al		A
†Spermaceti	pure		6	A
Spirits of Ether	as is			A
Spring spray (aut.) (controls)	as is			A
Stains	as is			A
Starch	as is			A
Stearic acid	1	aq	6	A
Steel wool	as is			A
Sudan III—322	5	o.	3	A
Sugar	as is			A
Sulfogene carbon	pure		3	A
Sulfogene golden brown	pure		3	A
Sulfonated oils	pure			A
Sulfosalicylic acid	pure			A
†Sulpharsphenamine	3	aq.		A
Sulphur	5 10	pet	9	A
Sulphur monochloride	1	CCl_4		F
Sulphuric acid	5	aq		A

	Per cent	Vehicle	Classification and where encountered	Action
Sulphurous acid	1 2	aq		C
Sumac leaves—fresh or dry	as is		5	A
Sunflowers—oil of	as is			A
Tallow	as is			A
Tannic acid	1	aq	3	A
Tar—solution of N.F.	10	aq		A
Tars (no covering; simply apply)	as is			A
Tartar emetic pdr	as is			A
Tartar emetic	3	aq	5	A
Tartrazine Yellow—640	pure		3 4	A
Terpineol	pure		12	B
Tetra-chlor naphthalin	50	o o		F
Tetra-methyl-diamino-benzophenone	5	alc.		B
Tetra-methyl-thiuram-disulphide	pure			B
Tetra-methyl-thiuram-mono-disulphide	pure			B
Tetralin—tetra-hydro naphthaline	20	o o.		C
Tetryl	sat	ether	11	B
Thiourea	pure		10	B
Thiuram sulphides	pure		10	B
Thyme—oil of	25	o.o.		D
Thyme—oil of	25	alc.		D
Thymol	1	pet.		A
†Thymol iodide	25	pet.		A
†Tin chloride (stannous)	10	aq	-	A
Tin foil	as is			A
Tincture veratrum viride U.S.P.	as is			A
Tintex—prop.	as is			A
Tobacco extract (always perform controls)	as is	aq	0	A
Tobacco leaf (always perform controls)	is			
Toilet waters	as is			A
Toluidin	10–50	o.o		F
Toluol	50	o	12	A
Toners (See under "Dyes")				
Tooth pastes, powders	as is			A
Tragacanth	1	aq	6	A
Triacetin	pure			A
Tri-chlor-toluol	50	o.o		F
Trichlorethylene	50	o.o.	12	A
Trichophytine (controls)	undil.			A
Tri-nitro-anisol	0 01	chlor		F
1 2-4 tri-nitro-benzene	1	acet.		A
1-3-5 tri-nitro-benzene	1	acet.		A
Tri-nitro-toluol	sat.	alc.	11	B
Trisodium phosphate	5	aq.		B
†Trypan blue 477—sodium salt of ditolyl disazo-bis-8-amino-1-naphthol-3 6 disulphonic acid	pure		3	A
Trypan red 438—sodium salt of 3-sulpho-diphenyl-disazo-bis-B-naphthylamine-3 6 disulphonic acid	pure		3	A
Tryparsamide	5	aq		A
Tuberculine (controls)	undil.			A
Tumenol	5	pet.		F
Tumenol ammonium	5	pet.		A
Turmeric	pure		5	B
Turpentine (controls)	50	o o.	1 2 5 9 12	A
Typewriter ribbon	as is			A
Tyrosine	sat.	aq		A
Ultramarine blue—double silicate of aluminum and sodium containing sulphur of unknown formula	as is			A
†Uranium chloride	10	aq		A
Urea	10	aq		A
Uric acid	1	aq		A

	Per cent	Vehicle	Classification and where encountered	Authority
Vanilla—oil of	25	alc.		A
Vanillin	10	pet.		F
Varnish (controls)	as is			A
†Varnolene	60	o.o.		A
†Venetian red (Ferric oxide Fe_2O_3)	pure		8	A
†Vert Emeraude	pure		8	A
Victoria blue	pure		3	A
†Vinegar	as is			A
Vinyl resins	pure			B
Vioform	5	pet.		A
Walnut—oil of	pure			C
Water colors	as is			A
Waxes—polishing in general (controls)	as is		1	A
Wheat—oil of	as is			A
Whitfield's Oint.—N.F	as is			A
Window sprays	as is			A
*Wintergreen—oil of	1	alc.		A
Witch hazel	as is			A
Woods—natural—painted, stained (controls)	as is			A
Wormwood—oil of	25	o.o.		C
†Xeroform	25	pet.		A
Xylol	50	o.o.	12	A
Yellow olive	pure		8	A
Zinc chloride	2	aq.		A
Zinc oxide	pure		6	A
Zinc peroxide	pure			B
Zinc stearate	pure			A
Zinc sulphate	10	aq.		E
Zinc white	as is		8	A
Zonite—prop.	1	aq	9	A

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CHAPTER VI

PROBLEM OR BORDERLINE CASES—MALINGERING

THE authors have from time to time encountered difficulty in dealing with skin diseases of unknown etiology which are considered compensable on account of claims made by physicians on theoretical grounds. We refer to such diseases as lichen planus, psoriasis, alopecia areata, and Raynaud's disease.

Lichen Planus.—Lichen planus is a disease that manifests itself in the form of typical polygonal papules commonly found on the flexor surfaces of the wrist, the inner side of the thighs, and over the lumbar region. It may, however, occur anywhere on the body. Eruptions on the wrist, frequently seen by the authors, are often mistaken for a disease of occupation. The disease is more common in men than in women. As it occurs in nervous, irritable individuals, the onset, or the exacerbation of an existing lichen planus has sometimes been blamed on mental shock. When an employee has undergone such a shock in his line of duty, the question of compensation arises.

This disease, like psoriasis, will arrange itself in linear formation wherever the patient traumatizes or scratches himself, but scratching will not produce a generalized eruption. On the other hand, the nervous element may be a result of the itching, and not the cause. The etiology is not known, and it is therefore unfair to consider shock in industry as a causal factor.

Acute lichen planus may spread rapidly and assume the picture of a generalized erythroderma. Characteristic lesions can be recognized in spots. Since this eruption spreads spontaneously without any known cause, it may readily be mistaken for a contact dermatitis at times.

Psoriasis.—Psoriasis, another rather common disease, manifests itself on the skin in fairly well circumscribed patches covered by silvery friable scales adherent to their base. It is generally found on the extensor surfaces of the extremities and presents a similar problem to lichen planus in industrial dermatoses. It also occurs in scratch marks in linear formation and is supposed to be exaggerated when the patient is under nervous tension. The etiology of psoriasis is also unknown, and the same conclusion applies as in the case of lichen planus.

Alopecia Areata.—This is characterized by sharply defined, well circumscribed patches of various sizes occurring insidiously on the scalp and beard, which become denuded of hair at the points of attack. The cause is absolutely unknown, and since such theories as physical or mental shock, infection, and endocrine imbalance have not been proved, claims in cases of alopecia areata attributed to industrial causes must be very cautiously decided.

Raynaud's Disease.—Raynaud's disease is a local asphyxia involving the extremities and due to a vasomotor disturbance of unknown origin. The affected parts develop paroxysmal attacks of ischemia and pain. Gangrene may be the final outcome. Wherever such a vasomotor disturbance exists we must admit that exposure to cold in various industries or to vibration from certain machines will precipitate an attack. However where there is no such immediate provocation the occupation cannot be regarded as having a causal relationship.

White Fingers.—Occurring among workmen who operate pneumatic tools, it is a condition characterized by pallor and a feeling of cold and tingling followed by loss of sensation and power of movement in the fingers. If work is persisted in the pallor is often succeeded by a slight hyperemia and a sensation of warmth. In some cases cyanosis follows. On stopping work the numbness disappears after a short rest or may last for several hours accompanied by a slight tremor of the hand but the symptoms are never permanent. Alice Hamilton after an extensive investigation attributed the condition to three factors: (1) long-continued muscular contraction of the fingers, (2) vibration from the tool, and (3) the action of cold. When disability occurs the disease is compensable in all states that provide blanket coverage for occupational diseases.

In all the above conditions compensation can be claimed in New York State if it can be shown that exacerbation of an existing disease is brought about by occupational conditions, and any syphilitic manifestation that is precipitated or aggravated by occupational injury is compensable. Also when an industrial dermatitis or injury predisposes to the exacerbation and spread of a chronic mycotic infection it comes under the category of aggravation.

It is the province of the courts to rule on compensability and unexpected decisions are sometimes handed down resting entirely on the court's interpretation of existing laws. Some general conclusions may be drawn from the following case which was reported in *Public Health Reports* No. 51, p. 1506, October 30, 1936.

An employee of a company engaged in the manufacture of women's dresses contracted pulmonary tuberculosis due to conditions of employment and had been awarded compensation for disability by the commissioner. The trial court, however, sustained an appeal of the defendants, and the plaintiff then appealed to the Connecticut Supreme Court of Errors. The higher court denied compensation on the following grounds.

In the workmen's compensation act an occupational disease is defined as "a disease peculiar to the occupation in which the employee was engaged and due to causes in excess of ordinary hazards as such." This was interpreted by the court to mean that "an occupational disease must be a disease which is a natural incident of a particular occupation and must attach to that occupation a hazard which distinguishes it from the usual run of occupations and is in excess of that attending employment in general." The court ruled

further that "it does not include a disease which results from the peculiar conditions surrounding the employment of the claimant in a kind of work which would not from its nature be more likely to cause it than would other kinds of employment carried on under the same conditions. In the present case the plaintiff's disease resulted from the conditions of her particular employment in the factory of the defendants. Other trades carried on under these conditions would have been as likely to cause the disease as the manufacture of dresses."

MALINGERING

Various irritants such as chemicals blunt or sharp instruments cigarette burns etc. may be fraudulently employed to produce skin lesions by persons wishing to escape work or to collect compensation insurance. Such impostors are usually intelligent and aware of what it is all about, thus differing from persons with neurotic excoriations and those having lesions due to hysteria

Unless a doctor has a fair knowledge of dermatology it is difficult for him in most cases to recognize the self inflicted lesions of the malingerer The experienced dermatologist receives an immediate slight shock or at least a sense of strangeness, from the bizarre appearance of the lesion or from perhaps only one or two of a group which do not correspond with his stored-up mental impressions of what might be called in this context normal lesions The inexperienced doctor has no such field or reference at hand and must judge the condition by means of objective criteria In most cases he will note that the lesion is of a destructive nature such as an ulcer erosion denudation or gangrene occurring on skin which is normal almost up to the very site. Gangrene of the skin *per se* is so rare that it raises at once a question of external trauma that may or may not have been self inflicted.

A large percentage of the lesions are chemical burns. Friction and the application of acids, alkalis, hot metals, sandpaper mustard croton oil lye salt, cantharides, and tobacco are common methods of production. The lesions are generally angular in outline instead of round and their arrangement is too regular to conform to the classical groupings of any known disease. If due to a liquid caustic they will be irregular in shape and may run down in streaks often with small distant burns where a few drops may have been spilled Stains on the fingers or nails or on the affected skin such as the yellow stain of nitric acid or the pinkish or brownish stain of phenol or odors like that of turpentine are strongly indicative

The site of the damage is an important diagnostic factor It is usually found on the readily accessible parts of the body and is unilateral on the left side in right handed persons and *vice versa*. The skin manifestation may consist of erythema, dermatitis venenata bullae ulcers, gangrene ecchymoses or tremors or scars from blows with blunt instruments or from kicks.

The patient themselves may appear to have a guilty look be sul-

len and may either refuse to answer questions or coöperate in any way or else go to the opposite extreme and be over voluble in explaining the cause of the injury

These points should put the examining physician on his guard. In most cases however it is best to conceal any sign of suspicion and appear to accept all explanations as true The patient is then likely to become overconfident and make contradictory statements that soon betray his false position. In certain cases a sudden startling accusation of fraud and a statement of the means by which the injury has been done will produce a confession but this method must be used cautiously as it makes some patients only more defiant and resourceful

Once the physician is satisfied in his own mind that the injuries have been deliberately self-inflicted treatment consists of caring for the wound according to its nature and covering the affected parts with an occlusive dressing of either starch or plaster of Paris sealed at the edges with collodion so as not to allow any irritant to be placed beneath the bandage by the patient The patient should then be put to bed and kept under strict surveillance day and night without his knowledge When he believes himself to be unobserved he is apt to perform some act that will prove him to be an impostor

CHAPTER VII

GENERAL METHODS OF TREATMENT OF OCCUPATIONAL DISEASES OF THE SKIN

The therapy of industrial dermatoses has an advantage over that of general dermatology due to the fact that in most instances the offending agent is known and by its elimination together with the use of soothing applications an immediate cessation of symptoms can be brought about. The common way in which the skin reacts to various irritants gives the industrial dermatologist a useful clue to the causative factors.

The majority of cases of industrial dermatitis occur in new employees and are mild in character. Such workers should be given a protective ointment to put over the exposed parts, proper protective clothing such as rubber gloves, aprons, etc., and kept on the job. Most of them will develop immunity. Those who do not should be given other work to do which will not bring them in contact with the irritant. This usually effects a cure. Attempts at immunization therapy and desensitization have not met with encouraging results thus far, except in the case of some plant toxins. Desensitization has been successfully accomplished by the subcutaneous or intramuscular injection of acetone and alcoholic extracts in oil of poison ivy, poison oak, ragweed, chrysanthemum, tulip and gaillardia. The injections are given in ascending doses beginning with very small amounts. Hyposensitization to poison ivy has also been accomplished in some cases by giving the extracts by mouth in ascending doses. The extract was diluted with oil and given in capsules. Some untoward reactions occurred such as pruritus of the anal orifice and in some instances a generalized eruption but those who persisted in the treatment, despite all this, showed a hyposensitivity as determined by patch tests. Bathing in very dilute solution of poison ivy and gradually increasing the concentration of the bath over a course of weeks has also given some favorable results.

The medical therapy of skin disease must be undertaken with caution, as in many cases treatment only makes the dermatitis worse. In applying medication to the lesions only the mildest ointments and lotions should be used, such as boric acid or calamine. Strong ointments are apt to irritate the skin and cause more dermatitis. Trifling eruptions are quickly changed to severe dermatitis by treatment with mercury, sulphur and many proprietary ointments. Diagnosis and treatment by doctors unfamiliar with skin diseases may also be disastrous, as many ordinary affections are mistaken for industrial dermatitis. For example, the authors have seen rhus dermatitis treated with salves in the erroneous notion that it was

occupational in origin It quickly developed into an extensive and severe eruption

The following suggestions for therapy and the various combinations recommended are simply given as examples and are therefore open to revision additions and modifications

We believe that most occupational dermatoses are exacerbated either by irritating applications scratching friction from clothing secondary infections, and occasionally by malingering before the patient comes for medical treatment.

As dermatitis venenata is the usual type of industrial eruption encountered we wish to base the following classification on our mode of attack in dealing with the various stages through which such lesions pass.

1 In acute dermatitis, presenting a vesicular eruption on an erythematous base with edema, etc. the continuous application of cold wet dressings is advised The following solutions have been found effective Boric acid solution Burrow s solution (Liq alumini acetatis) 1 to 10 parts water potassium permanganate 1 to 5 000 solution Lotio calamine et zinc, etc. These are to be applied for a few days and when the skin becomes dry and feels tight, boric acid ointment zinc oxide salve petrolatum olive oil albolene etc should be applied thickly When the dermatitis is extensive relief from pruritis may be secured by warm baths containing corn starch bran or oatmeal

2 Complications such as infections, erosions and ulcerations must be treated with antiseptics. Infected follicles and furuncles should be opened daily crusts removed and the lesions washed with any mild antiseptic solution followed by painting with an aqueous solution of brilliant green 0.5 per cent or gentian violet 5 per cent in alcoholic solution. If the infection is impetiginous Ungt. hydrarg et ammonium 3 to 5 per cent should be rubbed thoroughly into the lesions twice daily after washing with soap and water As some skins are sensitive to this medication however it must be discontinued immediately on the appearance of a superimposed dermatitis from the mercury and the eruption treated with wet dressings of boric acid

3 When the skin has become dry scaly fissured and crusted oily substances are indicated. We have used the following with good results Gauze soaked in olive oil mineral oil castor oil solid albolene unscented cold cream calamine liniment, a mixture of equal parts of calamine lotion olive oil and lime water shaken well to form an emulsion or a watery paste such as zinc-oxide amylum glycerin and water in equal parts, or a soft paste consisting of starch zinc oxide mineral oil and aqua calcis. Creams consisting of fats plus watery solutions are cooling soothing and softening It is best to bandage the parts well with rubber tissue cellophane or oiled silk and leave on for a few days at a time

4 Where eczematization with lichenification occurs counter irritants and reducing agents such as crude coal tar ointments

salicylic acid 10 per cent in oil alcohol or collodion and chrysarobin [illegible] per cent in ointment or chloroform have proved useful Roentgen-ray therapy however has shown good results in this type of eruption Alpine and infra-red rays seem to have a very limited use

5. Keratoses nodules and tumors can be removed in some cases with escharotics salicylic acid 20 to 40 per cent etc. but this treatment is less efficacious than surgical removal endothermy cautery CO_2 snow roentgen-ray or radium

6. Exuberant granulations can be touched up with silver nitrate chromic acid or acid nitrate of mercury or may be destroyed with endothermy or cautery

7 Chemical burns should be immediately immersed or flushed with water to dilute and remove the irritant and then treated aseptically in the same way as any other burn When burned areas are contaminated with grease oil tar or dirt we have found that applying gauze saturated with a mixture of liquid petrolatum parts 90 and Aerosol O T parts 10 and leaving it on for twenty minutes will help to painlessly remove the dirt and grease especially if the area is flushed with water after removing the gauze dressing The use of the cationic detergents for cleaning infected areas of the skin is also recommended Such of these quaternary ammonium compounds as Zephiran Emulsept and the Hyamines are suitable for this purpose. They are antiseptic detergents with good cleansing properties. They should be used in dilute solutions 1 to 1 000 as they are irritants in strong concentrations In some factories where there is a hazard from alkali burns as for instance in the manufacture of viscose a weak solution of acetic acid is kept at hand so that it can be applied immediately to the parts which have come in contact with the alkali It is doubtful whether this practice is better than flushing with plenty of water Acid splashes are treated in some factories with applications of lime water

8. Ulcers resulting from such corrosives as chromic acid and chromates zinc chloride and fluoride are best treated by thorough curettement of the base followed by aseptic dressings.

We have found in our experience that most skins are sensitive to analgesic agents and some to menthol or phenol Since the action of menthol and phenol as antipruritics is not important enough to subject the patient to the risk of further irritation we feel they can be omitted.

Special treatment for lesions that do not conform to the above types, such as scabies, blastomycosis sporotrichosis etc. will be described in the chapters dealing with these diseases.

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CHAPTER VIII

GENERAL METHODS OF PREVENTION OF OCCUPATIONAL DISEASES OF THE SKIN

The ideal means of prevention is to safeguard industrial operations in such a way that injurious chemicals cannot come in contact with the skin This can be done by totally enclosing dangerous processes.

Modern factories are being so constructed and equipped with automatic machinery that the worker need not come in contact with any of the chemicals used from the beginning of the manufacturing process to the very end New chemicals are brought to the factory in enclosed railroad cars and emptied by suction hose into enclosed storage containers from which they are sent through a closed system to the various retorts and kettles simply by turning valves. From these kettles the product is processed in totally enclosed machinery such as filters, grinders etc. and when finished is placed into closed shipping containers by means of hose or pipes. In some industrial processes where this is not possible or where old equipment is in use the workers must be protected by suitable clothing such as rubber gloves, impervious sleeves and aprons masks and goggles.

Where the irritant is a dust respirators should be worn and the filters should be inspected and cleaned daily The face should be greased with lanolin or a dry powder reinforced protective film before the respirator is put on so as to prevent irritation of the skin by the rubber margins of the respirator Gas masks are required in the presence of irritant fumes Rubber boots should be covered by the trouser legs to prevent the entrance of irritants at the top of the boots All protective clothing should be frequently inspected kept in good repair and cleaned daily For jobs in which there is a marked skin hazard clean work clothes and under clothes should be furnished daily by the management

Over processes which give off irritating dusts or fumes, a special suction ventilating apparatus should be installed so that these irritants cannot come in contact with the worker The workrooms themselves should have proper and adequate ventilating equipment so that dusts and fumes will have no chance to accumulate in any dangerous concentration. Rules for the use of protective clothing should be enforced When respirators or gas masks are furnished the men should be compelled to wear them. Petroleum jelly inserted into the nostrils several times a day will help protect the nasal mucosa

Cleanliness is of prime importance The floors and walls of the workrooms and all machinery and equipment should be kept

scrupulously clean. Convenient shower baths should be installed and the workers compelled to use them after work. Sufficient time should be allowed workers to take the shower baths after work. Enough showers should be provided so that in thirty minutes all the workers going off shift can be bathed. The workers should be paid for the one-half hour which they spend in cleaning up. In factories where there are special skin hazards a double set of locker rooms should be provided, one for street clothes and another for depositing the soiled work clothes. The employee on coming to work would strip and leave his clothes in the first locker room and then pass to the second locker room where clean work clothes await him. At the end of the work shift he would deposit his soiled work clothes in the locker room from which he had received them, proceed to the shower bath, and resume his street clothes. The favorable effects of such a routine have been demonstrated in oil refineries where the wearing of clean work clothes and the compulsory use of shower baths has stopped the occurrence of oil acne and oil boils and has decreased the incidence of skin tumors.

New applicants for work should be carefully examined and those having such predisposing skin conditions as have been previously mentioned should not be employed in occupations where there is a skin hazard.

We do not advocate preëmployment patch testing either with allergens unrelated to those the worker will encounter in the course of his occupation or those with which he will work. We do not believe that because a worker is sensitive to a substance such as poison ivy or paraphenylene diamine or dinitrochlorbenzol he is more likely to be sensitized to unrelated chemicals like bichromates or formaldehyde, etc. Also because we have found that a new worker is not sensitive to allergenic substances which he had not previously encountered. That he becomes sensitized only after working with the substance for five days or more. Besides all the above scientific objections to preëmployment patch testing, there are legal objections. If the applicant is rejected or discharged he has reasonable grounds for claiming that he was sensitized by the preemployment patch test to something to which he was not before sensitive. The preëmployment patch test has not the same status as the diagnostic patch test. In the latter case the patient submits to it as a diagnostic procedure. In the former the well applicant for a job is forced to submit to it in order to qualify.

Patch testing with substances to which a person has not been exposed is not advocated except in the prophetic patch test on volunteers (see patch testing).

The workers should be encouraged to report to the medical department all irritations of the skin, no matter how trivial, as soon as they are observed. There should also be frequent medical examinations of the workers to discover the presence of skin diseases which have not been reported. The physician in charge should have a working knowledge of dermatology and give appropriate

treatment or if he does not have such knowledge dermatological cases should be sent to a consulting dermatologist

Municipal and state laws should be formulated to compel factories to report all cases of occupational dermatitis either to the Department of Labor or the Department of Health and these departments should in turn report their cases to the United States Public Health Service It is only by knowing where industrial dermatitis occurs that we can hope successfully to cope with it

In view of the increasing incidence of dermatoses as compared with other occupational diseases municipal and state departments of labor or health should have divisions of industrial hygiene within their organizations, and inspectors should be required to make periodic inspections of factories in order to note the occurrence of occupational dermatitis and the safety measures adopted for its prevention Special studies should be made by the Bureau of Industrial Hygiene of any unusual outbreaks of dermatitis in order to determine the cause and to institute preventive measures Bureaus of industrial hygiene should strive for the passage of laws compelling factories to install proper safety devices against occupational dermatitis.

Insurance carriers should also have trained inspectors to investigate the factories of proposed risks before they are accepted If preventable hazards are found the risk should not be accepted until adequate safety devices have been installed Insurance carriers should also have trained sanitary and safety engineers who can devise and install safety appliances. The services of these engineers would increase the safety of the worker and financially benefit the insurance company The inspectors of insurance carriers can acquaint the superintendents and foremen of factories with the nature of the hazards present in the factory and how to guard against them and the foremen can in turn instruct the workers.

Manufacturers of chemicals should have laboratories to study the health hazards of their products and how these can be guarded against, and should impart this knowledge to their customers.

Plant physicians should take every opportunity to teach safety and cleanliness to the workers. They should also carefully investigate the causes of any unusual occurrence of dermatitis and if necessary call in consulting dermatologists and safety engineers to help discover the cause and to institute proper measures for prevention.

PROTECTIVE CLOTHING

Properly designed protective clothing is of great value in the prevention of occupational dermatitis. Closely woven cotton fabrics that are more or less impervious to dust are frequently used to protect workers from such irritant dusts as sodium carbonate calcium cyanamide etc (Fig 1) To give efficient protection such fabrics must be frequently cleaned Each worker should have at

least two sets of work clothes so that he will have a clean set to wear while the other is being laundered It has been found best to have the management of the plant undertake the laundering of such clothes because the worker himself is often loath to spend the money In one plant where such was the practice it was estimated that it cost the plant about 10 cents per day to furnish clean daily work clothes for each worker

FIG. 1 —Pouring molten T.N T Note respirator coveralls and gloves.

Impervious materials, such as rubber offer better protection against dusts than do fabrics and they also give protection against irritant liquids. Rubber gloves, aprons boots, and sleeves are impervious to water-soluble irritants (Fig 2) Rubber however soon deteriorates when exposed to alkalis petroleum distillates, or the chlorohydrocarbon solvents. For this reason it is rather expensive to use in occupations in which it comes in contact with these chemicals. Synthetic rubbers such as neoprene and buna are more resistant to alkalis and oils than is natural rubber but workers often object to wearing rubber garments. Some state that rubber causes them to perspire excessively and many of them are allergic to compounds in the rubber

We have found that some of the synthetic resin films, such as pliofilm manufactured by the Goodyear Tire and Rubber Company koroseal, manufactured by the B F Goodrich Tire and Rubber

Company and Vinylite manufactured by the Union Carbide and Carbon Company are impervious not only to dust and fumes but also to strong acids alkalis and petroleum distillates These materials may be made into sleeves aprons hoods and coveralls and they have even been experimentally made into gloves. They are comparatively cheap non-inflammable easily cleanable with soap and water and transparent so that the worker can see the bare arm or the clothes underneath This latter property removes the

FIG. 2.—Safety equipped crew ready to enter and clean acid tanks.

psychologic effect of the wearer's feeling confined It is true that these substances like rubber prevent the circulation of air on parts of the body which they enclose but this can be prevented by placing vent holes in the upper parts of the sleeves and in the rear of the coveralls, where such holes are not likely to allow the entrance of irritants. They can be made of such tensile strength that when worn as sleeves by machine operators they will tear if caught by cogs before they can draw the arm of the worker into the machinery

These films are affected by trichlorethylene and carbon tetrachloride and therefore are not suitable for protective films against these substances. The polyvinyl alcohol films are proof against trichlorethylene and carbon tetrachloride They are manufactured in the forms of gloves and called by the trade name of resistoflex. The polyvinyl alcohol are affected by water and therefore resistoflex gloves should not be exposed to it They may be cleaned with the volatile solvents.

Cellophane or regenerated cellulose can be plasticized with glycerine to form a pliable film capable of being made into protective clothing Cellophane is not affected by acids or petroleum solvents

and is also good protection against war gases However it is made hard and brittle by water and is also inflammable.

These disadvantages may be overcome by treating the cellophane film while it is being manufactured with ammonium sulfamate which makes it flameproof and by coating it with a water-soluble resin which makes it waterproof Cellulose acetate films are water-insoluble and may make suitable protective clothing

Leather gloves offer good protection against trauma and irritant or sensitizing solids and dusts Leather gloves should be made of soft pliable washable leather such as chamois. The seams should be finished and smooth. Coarse seams rub and irritate the skin causing dermatitis not only by mechanical friction but by rubbing into the denuded skin the irritant chemical particles which have fallen into the glove at the wrist opening Gloves for the protection of the hands from irritant chemicals should reach well up the forearms and should be worn under impervious sleeves, fastening at the wrists so as to prevent the entrance of irritant chemicals into the glove Aprons should reach well up to the neck and below the knees. Aprons are of special value in protecting the body from cutting oils. We emphasize the fact that in order for protective clothing to be really protective it must be cleaned daily

PROTECTIVE OINTMENTS

While protective ointments are low on the list of preventive measures they are often the only available means of protection In other instances they protect the skin from irritants which may escape into the air in spite of other preventive measures. Again the face cannot be covered by protective clothing and often the work must be carried on with bare hands, gloves being unsuited for work or impeding the speed of the operation Moreover workers dislike to wear gloves and seem to like to use protective ointments When a protective ointment is used the worker invariably removes it with soap and water immediately after work and so removes at the same time whatever irritants are on the skin This adds considerably to the protection supposedly given by the ointment

All protective ointments should have the following properties

1 They should be non-irritating and non-sensitizing

2 They should offer actual protection from the irritant.

3 They should be of such consistency that they can be applied easily

4 They should be easily removable after work and yet stay on while the worker is exposed

Types.—Protective applications may be divided into six classes

1 A *simple vanishing cream* which when rubbed into the skin fills the pores with soap which facilitates the removal of soil when washing after work

Type formula.

Stearic acid	20
Sodium carbonate	2
Glycerin	6
Water	78

Melt stearic acid; dissolve sodium carbonate in water and heat to same temperature as stearic acid. Pour hot alkali solution slowly into hot stearic acid, stirring the mixture while pouring and until cold.

2. Ointments which leave a thin film of a resin or wax on the skin and thus prevent the irritant from touching the skin. This class can be subdivided into (*a*) water-soluble films and (*b*) water-insoluble films. They may be in the form of ointments, emulsions or solutions. This class of protectives is sometimes called the "invisible glove" type.

The water-soluble films give some protection against solvents such as petroleum distillates, the solvent chlorinated hydrocarbons, and water-insoluble allergens such as trinitrotoluene and tetryl. They are easily removed by water and therefore often tend to flake off as the perspiration accumulates beneath them. To counteract this action they are sometimes mixed with fats and oils. Methyl cellulose, Irish moss, sodium silicate, karaya, quince seed mucilage, acacia, tragacanth, casein, Elastolac (water-soluble shellac), sodium alginate, and pectin are some of the water-soluble resins that may be used for this purpose.

The second type of films includes water-insoluble resins and waxes used to keep out water-soluble irritants. These resins have the disadvantage of requiring a volatile solvent in order to be applied and a special cleanser must be used for their removal. Such solvents and cleansers may defat and hence irritate the skin. Shellac and nitrocellulose are the most frequently used resins in this form of protective, and alcohol, ether, and acetone are the usual solvents. When such protective films are used it is advisable to apply an emollient such as a mixture of lanolin and cold cream to the skin after washing off the protective film. When a wax coating is applied as the invisible film, it is usually contained in a vanishing cream and a mineral oil is used as a softening agent.

The invisible glove type of film is also a good protective against dermatitis of the face from the edges of respirators and gas masks.

Type formula—2 (a)

Acacia	4
Tragacanth	5
Borax	2
Water	89

Dissolve borax in hot water. Powder and mix acacia and tragacanth and dissolve in solution.

Type formula—2 (b)

Gum benzoin	4
Beeswax	2
Anhydrous lanolin	5
Ethyl alcohol	89

Melt and mix lanolin and beeswax and allow to cool. Dissolve gum benzoin in alcohol and then dissolve lanolin and beeswax in the solution.

3. Protective ointments which cover the skin and fill the pores with a harmless fat to repel water-soluble irritants and prevent the entrance into the pores of harmful petroleum oils, greases and coal-tar derivatives. Because fat solvents must act on the film of fatty ointment before they can attack the skin this type of protective ointment also offers some protection against solvents by buffering their action on the skin. This class of ointments is difficult to remove with soap and water Therefore some manufacturers have added synthetic wetting agents to facilitate their removal This class is recommended against cutting oils greases creosote oil pitch excessive sunlight, and photosensitizing chemicals especially if they contain chemical and physical light screens. They can also be used to rub into the skin after work to lubricate and soften dry skin.

Type formula.

Anhydrous lanolin	70
Castor oil	30
Perfume q s.	

Melt lanolin and mix in the castor oil. Perfume when cool

4 Protective ointments which contain a non-irritant chemical intended to detoxify the industrial irritant For instance a cream to protect against alkalis may contain boric or benzoic acid intended to neutralize the alkali. The addition of an animal or vegetable fat or oil to such a cream further buffers the action of the alkali by combining with it to form a soap A protective cream against acids may contain soap and magnesium hydroxide intended to neutralize the acid A protective cream against such substances as poison ivy and vesicant war gases which are detoxified by oxidation may contain a non-irritant oxidiser such as the various oxidizing peroxides or one that gives off chlorine such as dichloramine T

Type formula.

Magnesium carbonat	5
Talc	5
Soap	30
Lanolin	30
Castor oil	28
Duponol	2
Perfume q.s	

Mix soap lanolin, and castor oil Incorporate magnesium carbonate and Duponol

5. Protective ointments which cause inert powders to adhere to the skin forming a protective covering against skin irritants The powders may be calamine zinc oxide iron oxide kieselguhr Bentonite and so on The adhesive or binder may be any of the water soluble resins used in the invisible glove type of cream These ointments are of value in protecting against water-insoluble allergenic substances such as the military explosives, and against physical agents which may pierce the skin such as sharp pieces of glass slivers of steel and thorns or fuzz on flowers fruits and vegetables

Type formula.

Zinc oxide	5
Talc	5
Iron oxide	1
Irish moss	2
Gum benzoin	2
Water	10
Alcohol	15
Vanishing cream	60

Dissolve Irish moss in water. Dissolve benzoin in alcohol. Mix with powders and incorporate into vanishing cream.

6. Protective applications against the photosensitizing action of the heavy coal-tar distillates, oil distillation residues, and excessive sunlight may contain such physical light screens as methyl salicylate, aesculin, cycloform, esculetin, menthyl benzoate, benzyl salicylate, quinine oleate, menthyl anthranilate, tannic acid, and tannates.

Type formula.

Lanolin	55
Castor oil	30
Titanium dioxide	5
Menthyl salicylate	5
Duponol	2
Perfume q.s.	

Melt lanolin and mix with castor oil. Incorporate titanium dioxide, menthyl salicylate, and Duponol.

These six types cover all the varieties of protective ointments. For instance the protective cream against poison ivy developed by the senior author corresponds to Type 4. It contains sodium perborate held in contact with the skin by a film of shellac dissolved in alcohol. As long as water does not come in contact with it the perborate remains inactive, but when perspiration or moisture touch it, the oxygen is liberated from the perborate. The film of shellac acts as a mechanical barrier.

Formula.

Sodium perborate	10
Shellac	10
Isopropyl alcohol	65
Titanium dioxide	10
Carbitol	5

Apply to hands and arms and allow to dry. To remove use soap and water.

The anti-flash cream to prevent burns from explosion flashes is essentially the same formula except that sodium borate is used instead of perborate.

Insect repellent creams and sun-burn preventive creams are also available.

The skin should be cleaned before applying a protective ointment, otherwise injurious chemicals may be sealed on the skin. Protective ointments should not be solvents for the irritants from which they are supposed to protect the skin because they will then place in solution chemicals which when undissolved would not injure the

skin Protective ointments should be applied several times a day the old ointment being first washed off This practice not only renews the protective film but also removes the irritant and thus prevents it from acting for long periods.

INDUSTRIAL SKIN CLEANSERS

Personal cleanliness is one of the most important preventives of occupational dermatitis. Therefore the use of suitable cleansers should be encouraged In an effort to remove speedily and completely tenacious soil or dyes from the skin workers often use harsh cleansers such as strong abrasive soaps with high alkaline content and powerful solvents. Dermatitis resulting from this harsh treatment is of frequent occurrence and such irritations of the skin are sometimes mistakenly attributed to the substances handled while working

Physical and Chemical Action of Detergents.—In order to know *what detergents are best adapted for use as industrial skin cleansers* something of the chemical and physical properties by means of which detergents remove soil from the skin should be understood

There are various theories regarding the action of soaps as cleansers Among others the following may be mentioned

1 Soap solutions emulsify oils the alkali set free when soap dissolves emulsifies the fatty material adhering to soil and enables the solution to carry away the loosened particles

2 The alkali liberated when soap dissolves acts as a solvent for greasy matter on the surface to be cleaned

3 By increasing surface activity and by wetting and penetrating oily substances the alkali loosens dirt and soil which are washed away in solution

4 The soap acts as a lubricant and allows dirt to be rubbed off easily

5 The hydrolysis of soap forms colloidal acid soap which in turn forms colloidal absorption compounds with the dirt.

There are various chemicals which when added to soap increase the detergent action Some of these aid the action of soap by increasing the free alkali content Such are sodium carbonate sodium silicate sodium metasilicate trisodium phosphate disodium phosphate sodium hexametaphosphate and trisodium borate

Some assist by softening the hard waters and permitting the soap to act Such are the water softeners—sodium hexametaphosphate (Calgon) chemical neutral metaphosphate (Paratex) tetra sodium phosphate (Phosphotex) and sodium tetraphosphate (Quadrafor)

Some assist by increasing the wetting power and surface activity of the soap solution Such are the synthetic wetting agents.

Wetting Agents.—In order that dirt may be removed easily from the skin both must be wetted by the cleanser Wetting agents lower the surface tension of liquids enabling them to spread over

the surface and penetrate into the pores. They also act as "surface active" agents thus enabling the solution to penetrate oily or waxy films making the dirt easily removable The molecules of wetting agents are composed of two essential parts one part attaches itself to the water molecule and the other attaches itself to the oil molecule. In this manner the molecule of the wetting agent brings together the otherwise immiscible water and oil molecules. Sulfonated castor oil and the synthetic wetting agents act in this manner

Wetting agents may be divided into 2 classes according to their electrical properties (1) The anionic and (2) the cationic. The anionic are the most numerous They are represented by such compounds as the (1) sodium salts of higher alcohol sulfosuccinates, (2) sodium sulfate of long chain alcohols (lauryl oleyl etc) (3) alkyl aryl sulfonates (4) alkyl naphthalene sulfonates. The cationic wetting agents are quaternary ammonium compounds. They are said to be antiseptic and to leave an antiseptic molecular film on the skin after use. They are inactivated in the presence of soap or other alkalis. Examples of such cationic detergents are alkyl phenoxy ethoxy dimethyl benzyl ammonium chloride N(acyl colamine formyl methyl) pyridinium chloride

Some synthetic wetting agents also have detergent and water softening powers and will act in hard or soft water acid alkaline or neutral solutions.

Solvents.—Organic solvents are sometimes added to soap to increase its solvent power and aid in removing fats oils greases and dyes from the skin. Soaps used to remove indelible inks and dyes often contain carbon tetrachloride naphtha dioxane and other hydrocarbon solvents Such soaps have a greater defatting action on the skin than ordinary soap

Action of Detergents on the Skin —Soaps and other detergents have a physical and chemical action on the skin itself Alkalis dissolve the keratin and emulsify sebum cholesterol and skin fats. Neutral or acid wetting agents, detergents and solvents act in a similar manner except that they do not dissolve the keratin Hence the prolonged action of strong soaps wetting agents alkalis, and solvents on the skin will result in dermatitis the dermatitis occurring more quickly on dry skins than on oily or normal skins.

In addition to this some skins may become allergic to alkalis certain fatty acids their salts, the synthetic detergents wetting agents, or organic solvents. All these facts must be considered in choosing the ingredients of a particular cleanser

The Requirements of an Industrial Cleanser —The requirements of a normal industrial cleanser are as follows

1 It should be freely soluble in hard soft cold or hot water

2 It should remove fats, oils and other soil without harming the skin.

3. It should not extract from the skin its natural fats and oil

4 It should not contain harsh abrasives or irritant scrubbers which not only will injure the skin but may also clog the plumbing

5 It should be handy to use if in cake form or flow easily through soap dispensers if in granulated or powder form

6. It should not deteriorate or become insect infested

In order to meet these requirements, a normal industrial cleanser for general use should consist of a superfatted neutral toilet soap containing a wetting agent or synthetic detergent, and a soft scrubber which softens or dissolves in water and does not clog the plumbing It should contain a minimum of free alkali and have a pH of 10 or less in a 1 per cent solution It should contain no silica quartz, pumice or feldspar nor any rosin fillers or organic solvents

Type formula for an industrial skin cleanser for general use.

Neutral toilet soap	30
Colloidal clay (Bentonite or Kieselguhr)	30
Santomerse (or other synthetic detergent)	10
Lanolin	5
Perfume	1

Mix colloidal clay and Santomerse. Heat soap and lanolin, and mix with the above. This may be pressed into cake form, or 25 parts of corn meal may be added to make up 100 parts and the mixture then made into a powdered soap A mixture of equal parts of potassium-coconut oil soap and sulfonated castor oil to which 1 per cent of a synthetic detergent is added makes a good liquid cleanser

Soaps for industrial cleansers should be sodium or potassium salts of stearic, palmitic or oleic acids. Colloidal clay may be added because it is a harmless product which aids emulsification. In localities where the water is hard, water softeners or the synthetic wetting agents and detergents should be added to the soap. When it is necessary to remove tenacious oils or greases from the skin the addition of ground corn meal or other soft cereal for a scrubber will aid the detergent action

If the soil on the skin is difficult to remove without excessive scrubbing which may injure the skin, it may be necessary to add one or more of the alkalis such as trisodium phosphate, to the cleanser When this is done the soap should be superfatted with lanolin to buffer the action of the alkali on the skin and then lanolin should be rubbed into the skin after the cleanser is used.

Although lathering does not necessarily add to the detergent powers of a cleanser yet it is a property which workers desire Coconut oil soaps lather well Sulfonated castor oil (Turkey red oil) increases the lathering of soap. Moderate amounts of alkali, colloidal clay and perchlorethylene when added to soap also increase lathering

Cleansers for Soap-sensitive Workers.—Workers who are soap- or alkali-sensitive or who already have chronic eczemas or dry fissured skins from the use of ordinary industrial cleansers should be provided with cleansers other than soaps. This also applies to workers who are exposed to the organic solvents cutting and other petroleum oils all of which defat the skin

Such cleansers can be made in solid cake form from mixtures of synthetic detergents with colloidal clay, kieselguhr, or meerschaum. Lanolin may be added to the cleanser for emollient purposes.

Suggested formula.

Nacconol (or Santomerse, Igepon, or Dupanol)	20
Lanolin	3
Colloidal clay	76
Perfume	1

Mix and press into cakes of suitable size.

Such cleansers can also be had in liquid form.

Suggested formula.

Neutral sulfonated castor oil	97
Pure castor oil	1
Santomerse (or other detergent)	2

Cleansers to Remove Hectograph or Indelible Inks.—Special cleansers are made to remove the stains of indelible inks from the skin. Such cleansers usually consist of soap, a wetting agent, added alkali, and an organic solvent, such as carbon tetrachloride, naphtha, or dioxane. They can be made in liquid form or in the form of a paste. In the latter form they may contain a scrubber.

A suggested cleanser paste for the removal of hectograph or indelible inks is as follows:

Soap	30
Sulfonated castor oil	16
Synthetic detergent	20
Trisodium phosphate	4
Dioxane	20
Colloidal clay	10

The use of this paste should be followed by rubbing into the skin a mixture of lanolin and cold cream as an emollient.

Cleanser to Remove the Stains of Dyes.—To remove the stains of dyes, the hands can be soaked in a 1:500 solution of potassium permanganate for five minutes and then in a solution of sodium bisulfite 1:100 until the stain of the permanganate is removed. The hands should then be washed with a superfatted soap, dried, and a mixture of lanolin and cold cream, equal parts, rubbed into the skin.

Indicator Soaps.—A class of soaps are being developed which indicate by the development of a color the presence of certain irritants on the skin. The first of these was an indicator soap developed by Norwood which showed a pink color on the skin as long as tetryl was present. The worker scrubs until no more color shows. It consists of potassium sulfite 5 per cent in liquid soap. Botvinick and Mason developed an indicator soap for fulminate of mercury.

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CHAPTER IX

METHODS OF INVESTIGATION OF OCCUPATIONAL DISEASES OF THE SKIN

In order to investigate intelligently the causes of occupational dermatoses one must at least have a sufficient knowledge of dermatology to distinguish from contact dermatitis such ordinary skin diseases as psoriasis impetigo urticaria pityriasis rosea etc In addition one should also have a fair knowledge of chemistry Actual investigations in factories will give one the knowledge of industrial processes which is also an essential requirement

Before we can hope for success in finding the cause of a particular outbreak of occupational dermatitis, we must have the experience and knowledge gained by studies of the normal skin hazards of occupational dermatoses in the basic industries. Such studies not only acquaint us with the irritating properties of various chemicals and compounds, but often lead to the discovery of health hazard not previously reported

In order to gain entrance to factories to make such studies, we must awaken the interest of the owners or managers and convince them of the importance of our work They must be assured that the findings will not be used to their detriment and that the study will be made in such a manner as not to interfere with the routine of the factory alarm the workers or cause labor troubles.

In proceeding with an investigation the first step is to discuss with the plant superintendent the occurrence of occupational diseases especially those of the skin, which to his knowledge have occurred in the factory and to obtain from him a list of the raw materials used and the products manufactured The next step is to consult with the plant physician if there is one or with the nurse or first-aid attendant concerning the kind of infections or diseases treated in the dispensary and obtain from them a little better conception of the incidence of skin diseases than may have been secured from the superintendent The next step is to examine the medical records if any have been kept as far back as two or three years and note the number of skin lesion treated the departments in which the patients worked and the causes given for their occurrence This often yields a clue as to which department of the factory has the greatest skin hazards It is also well at this time to request that the workers who have had occupational skin diseases or who are known to be affected at present be called into the dispensary to be questioned and examined This enables us to check and evaluate the criteria used by the plant physician in making a diagnosis of occupational dermatitis.

The superintendent is then asked to appoint someone familiar with all the industrial processes in the factory to escort us through

the plant In many instances he and the plant physician both accompany us in our inspection It is well to begin at the point where the raw materials come in and follow them through the plant until the finished product is ready for shipment. In each department visited, first interview the foreman asking him if he knows of any workers who have now or ever have had skin diseases and what in his opinion caused them Then go through the department and have the manufacturing processes explained Examine the hands and face of the workers for skin lesions, at the same time taking note of their work clothes whether they are clean or dirty whether protective clothing in the form of gloves aprons, boots respirators etc is worn Note the cleanliness of the room whether there are any safeguards such as ventilating hoods etc. on the apparatus and ask each worker if he has now or has had in the past any skin disease Primary inspection of the men at work takes but a short time not over half a minute to a man The same procedure is followed in each department notes concerning the industrial processes and hazards being taken

The names of the workers who are found to be affected with some skin lesion or who state that they have been affected at some time or other are taken and at the end of the day s work, or an hour or so before these workers are summoned to the dispensary for further examination.

The workers should be examined one at a time with only the plant physician nurse or first-aid attendant present. The patient is required to disrobe completely and his body is examined for the presence of skin disease of any kind. It is very important to strip the patient because in this way many conditions come to light that would otherwise be overlooked

A card record should be made for each patient noting his name age sex, and color and giving a detailed description of his occupation and the materials and chemicals with which he comes in contact A history of his previous occupations the date on which he began his present job and a history of the present skin disease, with date of onset and a description of symptoms should also be taken Then a detailed description of the skin lesion and its location is entered on the card Later on when the data become available a description of the patch tests performed the chemicals used the length of time they were left on and the final results should be added to the record A diagnosis based on all the data should next be recorded and the actual skin irritant named On the card also may be placed a heading 'Remarks, under which can be recorded any complicating skin lesions and the treatment advised such as change of occupation or temporary discontinuance of work, or continuance at the job with the use of protective clothing or ointments or both.

After all the workers found at the primary inspection to have skin lesions have been examined inspect whatever locker toilet and eating facilities there may be in the factory

Before patch tests are performed on the workers explain their

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their composition It is then necessary to trace the chemicals to their original source of manufacture in order to find out what they really are An outline of some actual investigations will serve to illustrate the methods

1 We were requested to investigate an outbreak of dermatitis in a cotton mill There had been no cases of occupational dermatitis in the mill up to that time and it was found that the cases occurred only among workers whose forearms came in contact with new heddle frames in the weaving machines. The frames were made of spruce and were painted with a yellow waxy varnish Investigation brought out the fact that the skin of the forearms touching the heddle frames was first affected Patch tests with the varnish scraped off the new frames gave positive reactions, while patch tests with the wood itself were negative Removal of the varnish from the heddle frames checked the occurrence of dermatitis This definitely established that the varnish was the cause of the trouble

To ascertain what ingredient in the varnish provoked the dermatitis, we visited the manufacturer of the heddle frames. There it was learned that the varnish was purchased from a different paint factory from the one which previously supplied the varnish that caused no dermatitis. It was also learned that some of the workers in the heddle frame factory who were engaged in applying the new varnish to the wood had contracted dermatitis. The names of all the cotton mills that had purchased the new frames were obtained and letters to them elicited the information that dermatitis had also occurred among their workers since they had begun to use the new heddle frames.

The makers of the varnish were then visited and from them we obtained samples of the ingredients contained in the varnish These were taken back to the first cotton mill reporting the outbreak, and patch tests with all the ingredients were performed on those workers who had suffered from dermatitis. It was thus found that chlorinated ceresin (a wax) was the chief irritant although a dark cumaron resin played a minor rôle in causing the dermatitis Patch tests performed in other cotton mills confirmed these results. The varnish maker stated that the chlorinated ceresin was added to the varnish to produce the smooth waxy finish which induced the heddle frame makers to discard the old varnish in its favor Under the atmospheric conditions prevailing in cotton mills (80 per cent relative humidity and 80° F temperature) the workers perspire considerably and the perspiring skin coming in contact with the chlorinated wax in the varnish caused a liberation of chlorine and this was the actual cause of the dermatitis.

2. While patch tests are a great help in determining the causes of occupational dermatitis, it is not always possible to use them and we must sometimes devise other methods of approach.

Two outbreaks of dermatitis among cable splicers occurred simultaneously in Chicago and in New York City and in no other place

although the process of cable splicing is the same all over the United States.

The workers affected had been patch tested by previous investigators and at first refused to submit to any more such tests. It was decided therefore to divide the operation of cable splicing into seven stages and to have the workers who had been affected and who were now well work a number of days on each stage then rest a few days before taking up the succeeding stage then rest again and so on In this way we hoped to find out at what stage of cable splicing the dermatitis actually occurred

It was finally found to occur during the operation of "boiling out" the green and blue paper wrapped wires in the cables. The boiling out is done with a mixture of paraffine and mineral oil for the purpose of removing all moisture from the wires The dyes used on the green and blue papers were malachite green and methyl violet. Although some of the stages of the operation consisted of boiling out other colored wires with this mixture no dermatitis occurred while splicing wires dyed with any other color Patch tests performed with strong concentrations of the two dyes produced dermatitis in some of the workers It is interesting to note that by the time this stage of the study was reached the workers had become so interested that they consented to patch-testing experiments.

Further experiments showed that in the processes of boiling out the dyes were partially decomposed and that the decomposition products were dissolved in the boiling-out compound The boiling-out compound was used over and over again and in this way it eventually contained a high percentage of these products of decomposition. When the compound was heated the decomposition products came off in the fumes and irritated the skin of hypersensitive workers. It was also found that at the time the outbreak occurred there was an extra large amount of cable splicing being done for the Chicago Fair and therefore the workers had an unusually great exposure to the fumes of the boiling-out compounds. Also that in New York City at about the same time new cables larger than any that had been laid before were being installed These cables contained 3000 strands of wire and entailed more splicing than is usually done These facts explained why the outbreak occurred only in New York and Chicago

It was found that when green and blue dyes of a different class were submitted for coloring the paper insulations on the wires the workers did not develop dermatitis from the splicing operations.

3. The industrial dermatologist is sometimes called upon to investigate the causes of outbreaks of dermatitis among the users of manufactured goods. The same methods of procedure are pursued To illustrate

A certain manufacturer of wrist watches decided to use jet black sweat-proof wrist straps on his products. He ordered these from a leather-strap manufacturer After approximately one hundred

thousand of the straps had been sold to stores, complaints and law suits began to come in because of dermatitis on the wrists of the wearers. The straps were submitted by the watchmaker to a leather research institute and to a well known dermatologist to determine whether they contained a skin irritant. Reports from both stated that they did not. Before contesting the law suits someone in the factory suggested that a number of the workers be asked to wear the straps as an experiment to see if any of them would develop dermatitis. Accordingly 50 workers consented to wear the straps and in a few days 6 of them developed a dermatitis of the wrists. This proved that the straps contained a skin irritant and the search for it was begun.

First the manufacturer of the straps was visited and from him it was learned where he purchased the leather and the dyes. The leather was bought from a jobber in New York who in turn had purchased it from another jobber who had gone out of business. After considerable effort it was found that the leather had been made in a factory in Lynn Massachusetts about five years previously and that it was a chrome-tanned calfskin. The process of tanning was disclosed. The chemical nature of the dyes was learned from the factory where they were made and samples of all the ingredients in the dyes were obtained. The workers who had worn the watch straps were patch-tested with the undyed leather, the dyed leather and with each of the chemicals used in the dyes. Positive patch tests resulted only from the dyed leather and from one of the dyes used in the dye mixture. This dye is commonly known as "butter yellow" and has the chemical name of amido-azo-toluene-hydrochloride. It had never before been reported as a skin irritant. In fact it was thought to be so innocuous that it had at one time been used to color edible fats. We found that the yellow dye was mixed in with the black dye (negrosine) in order to give the straps a jet-black color instead of the blue-black produced by negrosine alone. Elimination of amido-azo-toluene-hydrochloride from the dye mixture stopped the occurrence of dermatitis from the watch straps.

4 On the other hand dermatoses that have every appearance of arising from occupation are sometimes found on thorough investigation to have had an altogether foreign etiology. For example

The personnel of a large office complained to the management that there was an outbreak of dermatitis amongst them which they claimed was caused by carbon copies which they were all required to handle. They stated that the carbon copies were carrying infection or contained an irritant chemical. They threatened a sit-down strike unless an immediate investigation was made.

The investigation showed that there were only 20 cases of various skin affections among 700 workers, which is not a high incidence. Only 0 of these bore any resemblance to a contact dermatitis or to parasitic skin disease and even some of these had been present before the patients began work at that office.

Samples of all the carbon papers used in making the carbon copies were obtained from the manufacturers and patch tests were performed with them and with the actual carbon copies handled in the office of those affected with the skin diseases. The negative results convinced the investigators and the complaining workers that the skin diseases were not of occupational origin

CHAPTER X

DERMATOSES CAUSED BY PHYSICAL AND MECHANICAL AGENTS

The skin is exposed to and influenced by mechanical and physical forces in almost every occupation. Such factors as heat, cold, sunlight, electricity, pressure, and friction, play a part in the causation of some industrial dermatoses.

These mechanical and physical agents produce a wide range of manifestations varying from mild occupational stigmata such as callosities to dermatitis and even carcinoma. Clinically, there may be difficulty in distinguishing between some occupational stigmata and certain forms of dermatitis. However, the former usually affect practically all persons engaged in the same work, while dermatitis, depending on individual and constitutional factors, affects only a small percentage of any industrial group.

MECHANICAL INJURIES

Pressure and Friction.—Pressure and friction are mainly responsible for the callosities, hygromata, and deformities that constitute most of the so-called stigmata peculiar to certain occupations. Irritation from flying particles and dusts may produce pruritic manifestations and various forms of dermatitis.

Many stigmata cause little or no discomfort, and may even in some instances be of advantage to the workman; for example, callosities on the hands of glassblowers. These lessen the sensitivity of the skin at the point of friction. Many workers suffer intensely from holding the hot iron blowpipe until dense callosities develop on their palms; following this, they can handle the pipes without discomfort. As long as the pathological changes in the skin do not disable the worker, he is not entitled to compensation, but severe forms may cause disabilities serious enough to bring him under the scope of the Workmen's Compensation Law. They may also be contributory factors in the production of more disabling dermatoses. For this reason, a brief description will be given of some chronic conditions of the skin due to physical and mechanical forces.

Individual predisposition may play some part. For instance, a workman suffering from ichthyosis is likely to develop hard dark callosities from friction and pressure, while hyperidrosis promotes the formation of soft, translucent, yellowish areas of the skin. Extensive callosities, blistering, or atrophy may develop under excessive pressure.

The effects of mechanical forces are frequently accentuated by other agents such as heat or cold. In the operation of pneumatic tools, pressure combined with cold produced by the escape of com-

pressed air on the hands inhibits the circulation of blood in the fingers. Although permanent injury from this source is rare two cases of gangrene have been reported requiring amputation of the *fingertips*.

Atrophy of the skin occasionally occurs notably in the pottery industry In smoothing the damp material for making fine porcelain the palm is worn thin by friction against the wheel and the epithelium of the fingertips may be entirely lost

Oppenheim includes among the most important occupational stigmata of the skin callosities cornification pigmentation tattooing telangiectases and scars.

F 3 —Callosities on knuckles of leather stakers and glaziers

Callosities result chiefly from recurring irritation as by repeated pressure or blows (Fig 3) but chemicals and heat may produce the same effect Not only the skin but the cartilages bones muscles and joints may undergo modification from these causes The tissues adjacent t the callosity may become inflamed and give rise to severe dermatitis lymphangitis or necrosis Corns usually form over a joint and are similar to callosities but have a more sharply *cone-shaped formation the point of* which presses into the underlying tissues and causes acute pain Soft corns occur usually between the toes where the skin is subject to heat, friction and moisture In occupations that require much standing or walking

such as carpentry house-painting and plastering sales work in stores etc. fallen arches and other disturbances of the feet may produce corns that in some cases become disabling (Fig 4)

FIG 4 —Painful callous on feet of woman standing at work all day

Pigmentation.—Pigmentation occurs from exposure to the wind sun and excessive heat as well as from certain chemical agents. Agricultural laborers gardeners, gamekeepers, trappers fishermen coachmen messengers, soldiers sailors carpenters and other out door workers are subject to discoloration of the skin from exposure to the weather and workers in blast furnaces and foundries stokers blacksmiths locksmiths glass workers welders etc. from the heat encountered in their occupation Erythema from these causes is followed by pigmentation which may result in atrophy or the formation of warts and eventually of epitheliomas.

Depigmentation and pallor are occupational stigmata of persons working in darkness, *e g* miners and tunnelers.

Tattooing —Violent contact with hard sharp-edged substances such as stone or metal may drive particles of the material beneath the epidermis and cause a temporary or permanent pigmentation Such conditions are found chiefly among miners employees in the silver steel stone and powder industries electricians, chimney sweeps, etc. Black patches either round or pointed occur on the dorsa of the hands fingers and forearms with permanent globules above the joints. Workers in coconut oil and margarine factories may be affected by small particles of the vegetable capsules which pierce the epidermis, and sometimes produce a mild inflammation.

Cicatrization.—The location of scars resulting from small wounds is often characteristic of certain occupations A lesion on the right thigh made by a slip of the shoemaker s knife while cutting leather has been recognized as a mark of the trade ever since the time of Hippocrates. Such wounds become the site of pigmentation impregnation with deposits of dye etc. comedones, and infections. Coal miners may be marked with indelible blue-black scars on the face arms and upper part of the torso resulting from the impregnation of minute abrasions with coal dust Such pigmented scars are seen also among iron stone silver and flour mill workers, the discoloration varying with the materials used Among basket weavers linear firm scars and rhagades are frequently seen on the palms and palmar surfaces of the fingers.

Telangiectasis.—This affection may occur on the face and occasionally the neck and chest of workmen who are obliged to spend much time out of doors and also among those exposed to excessive heat indoors. Cooks blacksmiths gardeners etc sometimes suffer from dilation and new formation of the precapillary vessels of the face and hands. The condition is usually accompanied by hyperpigmentation and freckling cases of pure telangiectasis being rare Persons with delicate skins, chiefly women and children as well as those suffering from chronic congestion of the face due to various causes are predisposed to telangiectases.

Some of the commoner occupational stigmata which arise from physical and mechanical causes are shown below

Occupational Stigmata From Physical and Mechanical Causes

Occupation	Lesion	Location	Cause
Asbestos workers (carders, weavers, mattress makers)	Corns, warts	Palms fingers	Penetration of fibers
Bakers	Callosities	Palmar and cubital surface of little finger	Pressure on kneading board
Bead [illegible]	Excoriations thickening	Ulnar side of the hands	Friction of [illegible] dragged through rollers
Basket makers	Thickening	Ulnar side of the palms	Hammering canes with clenched fist
	Callosity and broadening	Thumbs	Bending and intertwining hard cane
	Cicatrices, rhagades	Palmar surface of fingers and the hands	Innumerable cuts from handling materials
Blacksmiths	Hygromata	Palms, fingers	Heat and pressure
Burnishers of metal	Multiple callosities	Hands	Pressure of tools
Butchers (dry smokers)	Hyperkeratoses	Palms	Hot water and resin used in depilation of hides
Cane cutters	Tenosynovitis crepitans	Wrists	Continuous movements
Carders	Tenosynovitis crepitans	Wrists	Continuous movements
Carpenters, joiners	Thickening hygromata	Thumbs, index fingers	Pressure of plane
Cotton mill workers Winders	Thickening	Right index finger	Guiding yarn into [illegible] slot

Occupational Stigmata From Physical and Mechanical Causes—(*Continued*)

Occupation	Lesion	Location	Cause
Doffers	Thickening	Web between the thumb and the forefinger	Friction from replacing bobbins
Cutters of clothing	Callosities	Thumb, fingers	Pressure of shears
Cutters of furs	Papilloma	Inner side of the thumb joint	Pressure of shears
Diamond cutters (rounders)	Deformity	Thumb, forefinger	Pressure
Engravers	Callosities	Palmar surface of little finger	Pressure of engraving tools
File cutters	Hypertrophy	Right little finger	Pressure
Fishermen	Dermatitis	Hands	Handling of cables and ropes wet with salt water especially if skin is abraded
	Frost-bite	Hands	Exposure to cold
Flax hecklers	Callosities	Right index finger	Pulling flax off pins
Flax spinners	Callosities	Hypothenar eminence of left hand	Blows from the flyer
Glass blowers	Keratosis, rhagades	Palms	Heat from blow-pipe stock grease containing pitch
Glove makers	Callosities, deformities	Hands and fingers	Pressure on knife and scissors
Grinders of lenses	Thickening	Middle finger	Friction from abrasives
Harp players	Thickening	Fingertips	Friction from strings
Hatters: Finishers	Callosities	Thenar eminence, fingers	Rolling cylinder with hands
Felt-hat sizers	Keratoses, rhagades	Palmar surface from wrist to fingertips	Friction and immersion in hot and cold water
Straw-hat makers	Callosities	Palms and fingers	Picking and plaiting straw
Hod carriers	Thickening	Shoulders	Weight bearing
Housemaids	Bursae	Knees	Kneeling on hard floors
Lathe workers	Hygromata	Palms	Pressure and friction
Leather buffers	Callosities	Thumb	Pressure and friction
Leather cutters	Callosities	Right index finger	Friction from tools
Leather glazers	Callosities	Knuckles	Friction from tools
Miners	Callosities	Hands	Friction from tools
Coal miners	Blue-black tattooing	Upper half of the body	Impregnation of skin with coal dust
	Bursae	Knees, hands and elbows	Undue friction
Moulders	Scars from burns	Dorsum of feet	Droppings of molten metal
Musicians	Chronic tenosynovitis	Long extensor of thumb	Due to position of hands in holding drumstick
Porters: Alabaster blocks	Fibrolipomata with superfluous hair	Shoulders	Weight bearing, friction
Boxes, cases, etc	Callosities	Shoulders	Weight bearing, friction
Timber	Hygromata	Hands	Carrying logs
Potters	Horny thickening, atrophy of skin	Left hand	Friction of revolving lathe

Occupational Stigmata From Physical and Mechanical Causes.—(*Continued*)

Occupation	Lesion	Location	Cause
Printers, compositors	Callosities	Fingertips	Pressure of type
Shoemakers	Callosities	Folds of fingers, thigh above patella	Pressure of tools
Cobblers	Scars from cuts	Right thigh	Cutting leather
Knotters	Trophic	Fingers	Vibration
Stenographers	Tenosynovitis crepitans	Wrists	Excessive movement
Stone workers	Hygromata, tattooing, pigmentation	Palms Dorsa of hands	Pressure of tools Impregnation with particles
Sugar workers	Callosities	Between fingers	Manipulating machine cutting cubes
Violinists	Thickening Fibro-fatty pad	Fingertips Left jaw	Friction from strings Friction from instrument
Washerwomen	Callosities	Inner surface of forearms	Friction against edge of washtub

Keratosis.—Keratosis may follow friction pressure chronic dermatoses frost bite ulcerations radio-dermatitis burns etc It is important to bear in mind the potential transition of this lesion into carcinoma. For this reason early removal is indicated The pathology of keratosis is that of simple keratoma at first benign it may later become cancerous Keratoses are likely to affect those exposed to the elements, *e g* farmers sailors drivers policemen industrial employees in contact with tar pitch oils aniline dyes lime paraffine physicians and technicians handling roentgen-ray apparatus radium and other radioactive substances chimney sweeps, and mule spinners in mills. Matzenauer has reported hyperkeratosis of the palms among butchers who remove hair from the hides of pigs.

Xeroderma.—Xeroderma, or dry skin is a hereditary condition which occurs in many persons and assumes various forms. In one form the follicles contain horny plugs and the skin presents a rough dry surface This condition is known as keratosis pilaris. The common locations are the extensor surfaces of the arms forearms thighs buttocks, and calves. This type of skin is highly sensitive to irritation and the authors stress its importance since the tops of the follicles frequently become irritated and inflamed from the friction of silk or woolen clothing This is seen especially in cool weather when heavy garments produce heat perspiration and friction. The sides of the neck and the shoulders where friction is greatest are favorite sites for a pinpoint papulo-follicular eruption. Body folds such as the cubital and popliteal fossae sites of friction plus retained heat and sweat are also commonly affected The calves of the legs among men are irritated by rough heavy trousers. It can readily be seen that an eruption such as this occurring on the forearms may be mistaken for an occupational dermatitis.

Keratosis pilaris may be a contributory factor in the causation

of an occupational dermatosis, since this type of skin is susceptible to irritation by mechanical or chemical causes. On exposure to continuous friction, pressure, or trauma, the skin at first becomes red, swollen, fissured and scaly, and occasionally vesicular. Later on it becomes dry, scaly, and thickened, and in many occupations callosities develop. These show hyperkeratosis and thickening of the granular layer microscopically. Fibrolipomata, true and false bursae or hygromata, as well as various deformities may ensue.

If a dermatitis in such patients is found to be due to the friction of clothing rather than to an occupational irritant, the condition can be easily controlled by wearing full length thin cotton underwear with long sleeves to cover the entire body from the neck to the ankles. The application of oil to the skin following a daily bath is a necessary adjunct.

Bursitis.—Inflamed bursae, both true and false, result from excessive pressure, motion, or friction to which workers are subjected in many occupations. Tenosynovitis crepitans of the wrists is seen among stenographers, typists, and others whose work requires long continued motion of the hands. Adventitious bursae may arise of the clavicle and shoulders of bricklayers and porters from the pressure and friction of carrying weights. Hygromata of the hands occur in numerous occupations from friction and pressure of tools.

Coal miners, especially in England, are among the greatest sufferers from occupational bursitis. The lesions occur most frequently on the knee since the miner is obliged to kneel during a part of his work, next, on the hands from the friction of his tools, and finally on the elbow which he uses to support his weight while hewing coal from low narrow tunnels. The lesions may become infected, and are then legally defined as subcutaneous cellulitis or acute bursitis. The early symptoms are heat, erythema, swelling, and pain, with pitting of the skin on pressure. Suppuration may follow and the adjoining bursae or tendon sheaths may or may not be involved. On the knee and elbow, the condition usually heals uneventfully within six weeks, but in the hand the tendon sheaths sometimes become infected and cause serious disability. One or two fatal cases due to septicemia have been reported.

This form of cellulitis occurs also among metal miners and occasionally in other trades, but the greatest incidence is among coal miners. Here the affection ranks second only to nystagmus* on the lists of compensable diseases, for the industry.

DUST IRRITANTS

Mechanical irritation of the skin by various dusts encountered in such industries as coal and metal mining, stone works, textile and flour mills, tanneries, etc., is more often a contributory factor than

* Miners' nystagmus is rarely seen in the United States where the tunnels are higher and wider than in England and the miner does not assume the horizontal posture.

the sole cause in the production of dermatitis It facilitates the entrance of bacteria fungi and other toxic agents Nevertheless, some dusts that are innocuous in themselves may when mingled with sweat cause a troublesome dermatoconiosis by occluding the sebaceous glands.

Acneform eruptions are well known among workers exposed to zinc dust. Papules with white centers appear on the scrotum and inner surfaces of the thighs or other moist covered parts and cause pruritis. Spicules of silica in the dust of siliceous earths used in the manufacture of scouring soap appear to be the cause of cutaneous lesions reported among workers in a New York soap factory In addition to bronchial irritation from this dust, the exposed parts of the skin develop pruritis, with occasional ulceration

Among millers particles of stone steel and other hard substances handled in dressing the stones penetrate the dorsal surfaces of the hands and arms and produce spots of dark grayish discoloration which are itchy

Plant fibers non-toxic in themselves may plug up the sebaceous glands and cause folliculitis among the workmen who handle them Jute dermatitis for example results from this type of irritation. (See Plants.)

Baker's Dermatitis.—In the study of the etiology of baker's dermatitis and also of the eczema that occurs among flour mill workers, occlusion of the follicles by flour has been blamed by some authorities. (See Bakery Trades.)

Button Makers.—Despite improved methods for dust exhaustion workers in this industry are constantly covered with an extremely fine dust which arises in the process of cutting drilling and turning the buttons on the lathe (See Button Makers.)

Cutting Tool Makers—Workers making cutting edges for cutting tools are exposed to the dust of the metals composing the alloy Allergic dermatitis occurring among them was found by tests to be due to sensitivity to metallic cobalt (See Alloys.)

Bone Grinders.—These are not only subject to dust irritations but also to erysipeloid from bones of diseased hogs

Cotton Mill Workers.—These may develop dermatitis from cotton linters in the air especially in hot weather

Jute Bag Makers and Handlers—Dermatitis is not infrequently caused by the coarse fibers of jute coming off the cloth as the bags are made and when they are used It has been suggested that dipping the bags or fabric in a thin solution of rubber and allowing them to dry will prevent the fabric from shedding

Wood Workers. Those engaged in sawing sandpapering and polishing wood often develop dermatitis from the mechanical irritation of the dust If the wood is one that causes dermatitis venenata, then the hazard of dermatitis is increased

The following are some of the occupations in which dermatitis may occur from the mechanical irritation of dust

Occupation	*Irritant dust*
Abrasive Makers	Emery carborundum etc
Ashmen	Ashes (alkali carbonates)
Bakers	Flour and flour conditioners (persulfates)
Bone Grinders	Bone dust
Broom Makers	Coarse vegetable fibers
Button Makers	Bone and resin and shell dust
Carpenters	Wood dusts paints, lacquers, resins, rosin on nails
Carpet Cleaners	Fabric dust and house dust
Cotton Mill Workers	Cotton lint and dust
Cutting Tool Makers	Metal dust cobalt
Feather Workers	Feather dust, dyes
Felt Hat Workers	Fur dust, mercuric nitrate (carrot)
Fertilizer Makers and Handlers	Nitrates, phosphates, cyanamid, bone, blood castor pumice etc.
Flour Mill Workers	Flour flour conditioners
Fur Workers	Animal hair dander arsenical dusts, paraphenylenediamine
Graphite Lamp Black Carbon Black Charcoal Coal Workers	Carbon
Jute Bag Makers and Handlers	Jute fibers
Rag Pickers	Bacteria, house dusts, fungi
Street Cleaners	Dusts of all sorts
Wood Workers Wood Polishers Sawyers	Wood dust poisonous woods polishes, lacquers

INJURIES FROM PHYSICAL CAUSES

Heat.—Calorific Rays.—Long-continued or frequent exposures to moderate heat may cause a variety of changes in the skin of such workers as cooks bakers stationary engineers, stokers furnace men glassblowers, and foundry men Urticaria due to heat has also been reported

Prickly Heat (Lichen Tropicus, Miliaria) is a common reaction of persons who sweat profusely while exposed to heat. It consists of pinpoint to pinhead sized papules and vesicles involving the sweat ducts of the chest back submammary inguinal and axillary folds. The eruption occurs among cooks, bakers laborers Turkish bath attendants and others who do hard manual work, especially during the summer

Intertrigo.—Intertrigo or chafing arises under circumstances similar to those causing prickly heat in the folds of the body Due

to excessive perspiration and friction tiny pustules, furuncles and erosions resembling burns may appear on the parts where opposing surfaces of the skin rub against each other. Treatment in the early stages consists in thorough cleansing and the application of a fine dusting powder of zinc stearate with acetanilid, bismuth, zinc oxide or French chalk, and protection of the parts from further chafing with a thin strip of lint, gauze or antiseptic cotton.

Hydrocystomata.—Hydrocystomata are tiny sub-epidermal cysts which are due to dilation of the sweat ducts. The condition is seen most frequently on the face and neck of cooks and washerwomen who are exposed to heat while working. The lesions are clear, deep-seated, pinpoint to lentil sized cysts which do not rupture but disappear spontaneously. The eruption is readily controlled by roentgen-ray therapy.

Erythema ab Igne.—This is a chronic livedo-like eruption which occurs in reticulate patches on areas of the skin that are exposed to greater heat than the rest of the body, *e. g.*, the knees and legs of persons who habitually sit near a radiator or fire. The lesion assumes a lattice-work pigmentation, at first purplish in color and later turning to pale brown. The meshwork appears to correspond to the distribution of the superficial circulation. Workers in any industry exposed to excessive heat, *e. g.*, furnace and foundry men, cooks, stokers, and glassblowers, are subject to this condition. The authors have seen it chiefly among stenographers with poor peripheral circulation who "hug" the radiator in cold weather. Persons with delicate skins, under the same conditions, may develop multiple telangiectases.

Eczema Erythematosum.—Eczema erythematosum may occur among susceptible persons, usually on the face, from exposure to intense direct heat. It usually begins as a diffuse area of redness and is followed by slight swelling and considerable thickening of the skin. There may be intense itching or burning. The skin is a dull purplish-red, sometimes mottled, and begins to scale after a few days. It is not uncommon for this dry eczema to change to a moist form. The condition has been observed among goldsmiths and workers with precious metals and is due to the heat of the crucibles in which the metal is melted. The disease is likely to become chronic, with thickening and increase of the folds of the skin. When it occurs on apposed surfaces, the superficial epidermis may be denuded by maceration and friction.

Epithelioma.—While no single factor has been discovered to be the essential cause of cancer, it has been observed to follow trauma and long-continued irritation from physical, mechanical, and chemical forces. It may be questioned whether heat alone can produce cancer, but a keratotic area caused by prolonged or frequent contact with very hot objects may undergo malignant change. (See "Cancer in Industry.")

BURNS

The most frequent sources of occupational burns and scalds are
1 Solid Bodies.—Heated metals, molten resins rosins, pitch and other substances which solidify at once on contact with the skin
2 Liquids, such as hot water and heated fats and oils which spread over the surface of the skin to a greater or less extent according to their density
3. Gases such as steam and hot air
4 Flames from ignited materials such as wood coal petroleum alcohol and gas flames from welding lamps explosive mixtures of inflammable gases. In explosion or ignition temperatures may reach 3000° C. and very rapidly produce grave injuries.

Burns from steam and hot water are likely to be less severe than those from hot oil liquid resin or liquid metals and are usually of the first or second degree

Explosions frequently cause burns of several different types.

Asphalt and tar may produce superficial burns or deep lesions which require débridement

Welding by blowpipe causes many injuries among metal workers tinsmiths, chiselers engravers incandescent lamp makers etc They usually appear as distinct linear lesions on the backs of the hands the fingers or the interdigital webs.

Tailors and pressers often get burns of the hand and arm (the left, almost invariably) from steam arising from the wet material in contact with the hot iron These are usually second degree burns consisting of erythema and blisters.

Bakers, confectioners cooks, and kitchen workers are frequently burnt by flames from the stove or by contact with hot molds, splashings in the process of cooking and by steam hot coals, and cinders.

Numerous cases of scalding occur among washerwomen in private homes and in steam laundries. Ironers in laundries often get burns on the three middle fingers of the left hand while passing the clothes between hot cylinders.

Workers in distilleries, breweries, chemical factories, sugar and petroleum refineries silk works dye works and similar large industrial establishments are exposed to scalding by steam or boiling liquids while opening valves pipes covers etc. These burns are usually of the second degree In smaller concerns, burns are most frequently reported among bakers, confectioners engravers metal founders tailors, bookbinders hook makers upholsterers house painters, and mechanics (Fig 5)

Mechanical engineers and other employees of foundries and metal works may be burnt by slag and splashings of liquid metals. Putting material into hot furnaces has frequently caused severe injuries but the introduction of mechanical processes is largely reducing the risk from this source Despite the use of machinery for many

processes, certain hazards are still present, *e g* that of tapping the molten metal as it flows into the ingot molds and the cutting pressing and rolling of incandescent blocks and bars. Burns on the top of the foot from droppings of molten metal are characteristic of this occupation Forty per cent of the burns in metal works occur in these various processes Flying particles of hot metal also frequently cause injury to the eyes.

Firemen are especially exposed to burns by reason of their work although this risk has been greatly reduced by modern protective measures.

Employees of gas works especially pipe jumpers who clean the pipes are subject to burns from hot tar

Fig 5 —Oleum burn in chemical worker

Sequelæ of severe burns are scars (Fig 6) contractures, keloids and occasionally epitheliomata Toxic erythemas, either morbilliform or scarlatiniform may occur a week or more after the injury

Extensive burns may be accompanied by symptoms of shock with marked prostration and complications such as nephritis erysipelas septicemia tetanus and broncho-pneumonia with fatal termination

Treatment of Burns.—The affected parts should be cleansed as well as possible bullæ opened and liquid petrolatum or petroleum jelly applied as a dressing The affected areas should be kept under a tent and heated with electric light bulbs.

Spraying or painting with a 5 per cent alcoholic solution of gentian violet or a 2 per cent solution of brilliant green has proved efficacious in some cases. A mixture of 1 per cent aqueous solution of gentian violet acriflavine and brilliant green applied with a spray is also recommended

Supportive measures and symptomatic treatment are those generally advised for severe burns with shock.

Electric Burns.—These injuries bear little resemblance to those from other forms of heat. The wounds are painless, dry, aseptic and their appearance is characterized by circles, straight lines and tubular forms. The epidermis which remains is usually grayish, slightly elevated, hard, with insensitive edges and no surrounding erythema; the hairs nearby are not damaged. At first sight these burns often seem trivial and superficial, but within a few days there may be a breaking down of tissues that appeared normal, and complete necrosis down to the bone may develop.

FIG. 6.—Results of sulphuric acid burns in an oil refinery worker.

The burns may occur on any part of the body that comes in contact with an electrical conductor. The arcing of the current generates tremendous heat which renders the wound dry and sterile. The degree of injury depends upon the voltage, amperage, length of exposure, size of the point of contact, and resistance of the skin. The points of entrance and exit of the current generally show the greatest degree of trauma.

It is commonly believed that more severe burns are caused by alternating current than by direct, but Fisher, after twenty years' experience with over 1,000 cases, states that the type of current makes little difference. Although direct currents contain a much lower voltage, he has seen just as serious burns from low voltage as from high, and there is always the possibility of a fatal outcome due to ventricular fibrillation caused by a low voltage current.

With any electrical burn there may be more or less shock. This accounts for the high mortality since other constitutional complications are rare. Long contact with the conductor produces a greater degree of shock and more extensive destruction of tissue even to the point of charring and actual cremation.

A dry skin is resistant to electric current and concentrates the effects while a damp surface offers less resistance but tends to spread the injury over a larger area with less serious results.

All burns pass through three states (1) Erythema pain and swelling (2) exudation of serum with blister formation (3) granulation scar formation and contracture.

Electric burns heal spontaneously although the process is very slow. The tissues undergo necrosis without pus formation. After sloughing a clean pink area of granulation appears and develops into soft scar tissue. There may be slight or extensive edema about the wound.

Neglect in treating small superficial burns has frequently led to serious complications with loss of an anatomical part and even death. Conservative treatment is recommended. Since it is difficult to determine the extent of the damage to underlying tissues in first and second degree burns surgical intervention may bring on a hemorrhage difficult to control and which a burned patient in shock is little able to afford. Furthermore secondary hemorrhages frequently occur and patients have been known to bleed to death through their dressings a considerable time after the operation. Some authorities minimize these risks and believe that immediate resection or débridement of the necrosed tissues should be done to promote healing and lessen the subsequent deformity resection of the eschar en bloc is followed at once either by primary suture or by skin grafting. However most observers strongly advocate conservative treatment. In either radical or conservative therapy there is always great danger of complications during the second or third week at which time severe hemorrhage may occur due to the fragility of the nearby blood vessels. During this period the patient should be watched closely.

The object of treatment in electric burns should be to prevent dehydration and to reduce the high concentration of the blood that is usually present. There should be strict maintenance of asepsis. Measures should be taken to promote epithelization and attention should be given to the correction of contractures excessive scarring or any other complication.

Fisher warns against frequent dressing and the use of greasy ointments since these favor the growth of bacteria. His first measure while the wound is still dry and aseptic is to cover it with sterile petrolatum and light bandages of sterile gauze. For third degree burns he uses sterile fluffy gauze before bandaging. Blisters are opened and the dead epidermis removed under strictly aseptic conditions. All crusts are removed as soon as they become

loosened Skin grafting if necessary should be done as soon as the wound exhibits a healthy surface

The vast majority of electrical burns are incurred industrially Mechanics, engineers and workmen in electric power plants transformer stations, and factories making electrical equipment employees of mines railways, mills foundries, factories and machine shops in which electric light and power are increasingly used telephone linemen repairmen and inspectors operators of "live" switchboards employees in stores, apartment houses, hotels and private homes, in fact all persons who may come in contact with electrical machinery high tension wires or apparatus having defective insulation, are subject to injuries ranging from slight burns to electrocution

Lightning.—Burns from lightning are similar to those caused by electric currents. They seldom occur on the covered parts of the body although in some instances the clothing is stripped off by the force of the stroke. The lesions are usually spiral in form. Metallic objects such as coins keys, rings etc. act as conductors and burns occur on the skin which is in contact with them Such areas will show red radiating marks or even wounds

Injury from lightning is an industrial risk chiefly of outdoor workers such as agricultural laborers, shepherds, and foresters.

Cold.—Injury to the skin may occur in any occupation where workers are subject to prolonged low temperatures. The injuries range from simple erythema roughness, and chapping to gangrene and loss of an anatomical part. Industrial diseases of the skin from cold are infrequent, and it is difficult to establish this factor as the only cause in many cases. Defective circulation and lowered resistance are predisposing factors and inadequate clothing is often largely to blame Cold dampness, and frequent abrupt changes of temperature cause the greatest degree of injury Urticaria caused by cold has also been reported.

Livedo Reticularis.—Livedo reticularis is a frequent result of cold in persons who are in poor physical condition A reticulated purplish mottling of the skin which follows the outline of the peripheral vessels, similar to erythema ab igne develops after exposure to cold.

The first effect of unaccustomed exposure to cold is contraction of the vessel walls and reduction of the blood flow to the area. Since the circulation is sluggish in the extremities these are the parts most frequently involved If the exposure is prolonged and the cold severe, the vessels may become completely closed and lead to chilblains and frost-bite.

Chilblains (Erythema Pernio).—This condition is characterized by a bluish-red color and clamminess of the skin, accompanied by itching and burning The color disappears on pressure Among outdoor workers the condition clears up in warm weather and recurs with the return of cold weather Pernio may closely resemble the early stages of lupus erythematosus, but is differentiated by these

seasonal fluctuations. Cases have been reported, however, in which typical lupus erythematosus has developed on the site of a recurrent pernio.

Frost-bite (Dermatitis Congelationis) is a severe form of pernio produced by more intense cold and more prolonged exposure. The condition may be considered in three degrees. (1) There is pallor and complete loss of sensation, followed by tenderness, redness and swelling. (2) The edema and erythema are increased and may be accompanied by the formation of vesicles and bullæ which subside in a few days without sequelæ. (3) Ulceration, necrosis and gangrene with complete loss of tissue may occur. The affected area is at first white, cold, insensitive and shows no evidence of circulation. Later, sanguinous bullæ may form, or the skin over the area may be smooth, pale and marbled with bluish lines. Gangrene supervenes and soon afterwards the line of demarcation is seen. The gangrenous part may drop off with subsequent healing or septicemia may develop and lead to a fatal termination.

The effects of cold are increased by wetness and frost-bite may occur from immersion in water above the freezing point. Numerous cases occurred early in the World War when soldiers frequently stood in wet trenches for days without taking off their boots. Pressure of the boots together with the cold water produced lesions varying from erythema to gangrene. Edema, bullæ and dry gangrene frequently occurred.

Similarly in industries which require constant handling of wet materials, or in excavating work which necessitates standing for long periods in mud or water, cold may produce frost-bite of the first and second degree. Cleaners and washerwomen, who are exposed to wet and cold frequently develop anesthesia and asphyxia of the fingers, which disappear on stopping work.

Treatment of frost-bite consists in the administration of hot drinks and gradually raising the external temperature, together with moderate friction. Rubbing with snow, if this is obtainable, is recommended; otherwise the member should be bathed in cold water. Rapid change in temperature must be avoided since it causes pain and injury to the tissues. If these measures are applied persistently, many cases of frost-bite that appear hopeless can be cured. The usual antiseptic dressings for sloughing and ulcerating areas should be applied. If the destructive process is far advanced and the line of demarcation appears, surgery is indicated.

Angiokeratoma.—Following chilblains, or associated with them, pinhead sized vascular warty lesions may develop on the dorsa of the fingers or toes, or on the scrotum. The nodules are usually discrete and of a dull red or dark violaceous color. In time the surface of the lesions becomes keratotic. Removal by endothermy cautery, or electrolysis is the usual treatment.

Those most exposed to frost-bite of the hands and feet are soldiers, agricultural workers, foresters, woodcutters, gardeners, roadmenders, night watchmen (especially outdoor watchmen), customs

officials policemen aviators (at high altitudes) night porters, workers in the ice ice-cream and refrigerating industries fish vendors, and vendors of other foodstuffs. Cold-storage porters may show swelling and deformity of the pinnæ due to frost-bite from carrying frozen carcasses over their shoulders. Oppenheim states that in the ventilation of gas pipes by the use of carbonic acid snow compressed carbon dioxide may come in contact with the workman's fingers and cause second degree frost bite.

Fig. [illegible]—Recurrent multiple epitheliomas (California oil field worker) Actinic rays.

Sunlight.—Over-exposure to sunlight causes painful and serious lesions of the skin ranging from erythema to malignant growths. Long-continued work in the sun as in the case of farm laborers fishermen sailors etc may produce pigmentation freckles dryness scaling telangiectases, keratoses, and finally epitheliomas (Fig 7) Certain preexisting diseases such as hydroa æstivale xeroderma pigmentosum lupus erythematosus and pellagra may be so aggravated by sunlight as to end fatally Persons so affected should not be employed in occupations which require exposure to sunlight

Sunburn (Erythema solare)—The late spring summer and early autumn in this climate are the seasons when sunburn is most prevalent In certain sections of our country such as Lake Placid New York and Sun Valley Idaho where winter sports are popular and where there is high elevation and bright sunshine sunburn also occurs in winter

The burning rays of the solar spectrum are those between 2,900 to 3,200 angstroms. Wave lengths between 3,300 to 3 050 angstroms can produce tanning without sunburn. Exposure to the sun between 10 A.M. and 2 P.M. when the rays of the sun are most direct produces the greatest amount of sunburn. It is difficult to get sunburn

after 4 P.M. Sunburn is acquired sooner at high altitudes than at low altitudes because at high altitudes there is an increase of intensity in the spectrum band 2,900 to 3,200 A, that contains the burning solar rays Because the rays strike the atmosphere most directly in the tropics, and because there are more hours of sunshine sunburn is more easily acquired there than in other climes. Because snow ice water and sand reflect the burning rays of the spectrum sunburn is more likely to occur on sunny days where such conditions are present as at the mountains and the seashores.

Predisposing Causes—Blondes are more susceptible to sunburn than brunettes this is accounted for by the deficiency in blonde skin of the light-screening pigment melanin, but under certain conditions even negroes can suffer with sunburn. Negroes engaged in road making and roofing who are in contact with heavy coal tar distillates such as are contained in asphalts and pitch may become photosensitized and suffer from sunburn There are many other chemicals and substances which may photosensitize the skin and make it more susceptible to the rays of the sun The fluorescent dyes such as brom fluorescin used in certain lipsticks rhodamine B and lithol red used in nail lacquers oil of bergamot the juice of figs, buckwheat and certain grasses, are some of the well known photosensitizers.

Small children burn more easily than adults of like complexion Persons affected with certain diseases as for instance tuberculosis and hyperthyroidism are predisposed to sunburn

Symptoms—The degree of reaction to sunlight varies with the individual and the time of exposure It may consist of only a mild erythema which becomes manifest a few hours after exposure or it may proceed to extensive blister and bleb formation. The maximum intensity of the reaction is reached in from twelve to twenty-four hours after exposure In severe cases, constitutional symptoms such as chills fever headache and delirium may be present. The lips may be affected and there may be edema, and inflammation of the conjunctiva. The face, the skin in front of the elbows and the legs are affected more easily than other body parts.

Sunburn is usually followed by itching desquamation and tanning or pigmentation of the skin. Freckles often ensue. The skin in many cases becomes thickened. Brunettes may tan so much after repeated exposure that they no longer burn. The tan and the thickened skin protect against further sunburn. Those who cannot tan such as blondes may suffer severely upon repeated exposure

Persons habitually exposed to sunlight may develop a rough dry fissured skin on which keratoses may form the so-called sailor's, farmer's fisherman's and tropical skins. In a small percentage of such cases, skin cancers may occur Sunburn may in some cases be the cause or the beginning of such dermatologic conditions as urticaria vitiligo herpes simplex telangiectasia,

hydro-aestivale and lupus erythematosus. These diseases when present are aggravated by sunlight.

Differential Diagnosis.—Usually there is no difficulty in making a diagnosis of sunburn. The history of exposure, the erythema, edema, or blistering on the parts exposed make the diagnosis. In some cases dermatitis due to the photosensitization of the skin by meadow grasses may be mistakenly attributed to only sunburn. In cases of dermatitis of the uncovered parts of patients, it should be ascertained whether the patient had reclined on grass or vegetation while in the bathing suit and, if such a history is elicited, meadow grass dermatitis should be suspected. In meadow grass dermatitis the posterior surface of the body is mostly affected and the face and anterior surface of the elbow space are usually free. Patch tests with various meadow grasses may be used to establish a diagnosis.

Dermatitis from sensitivity to the bathing suit may be differentiated by the fact that the parts covered by the suit are inflamed.

Dermatitis may occur as a result of sensitivity to some chemical in the suntan preparation. This should always be borne in mind. Such a dermatitis occurs on the parts exposed to the sun and may require a careful inquiry and patch tests to differentiate from sunburn. If a known efficient suntan preparation was properly used and the exposure was not excessive (more than four hours of bright sunlight) then sensitivity to the suntan preparation should be suspected.

Lupus erythematosus, especially in the early stages, on the face may be mistaken for sunburn because it sometimes begins after exposure to the sun. The subsequent course of the disease establishes the diagnosis.

Treatment.—The treatment of sunburn depends on its severity. Mild cases with a simple erythema may use a simple drying powder consisting of equal parts of zinc oxide, boric acid and talcum. In cases of moderate severity where there is some edema, wet dressings of a solution of aluminum acetate 1 to 500 may relieve discomfort. After swelling subsides, wet dressings may be replaced with soothing creams such as

Benzocaine	ʒ
Methyl salicylate	♏
Cold cream	℥

In severe cases the blisters and bullae should be opened antiseptically and wet dressings of cold aluminum acetate 1 to 500 or saturated cold solution of boric acid applied. After the oozing ceases the soothing cream may be applied. Compresses of cold white mineral oil will give more relief in some cases than wet dressings.

Prevention.—The best method of developing a tan without burning is gradual exposure to the sun. On the first day at the seashore only expose the skin for fifteen to twenty minutes to bright

sunlight and increase the time of exposure by ten minutes each day until the tan and tolerance are developed or expose the skin after 4 P.M. on the first day for an hour on the second day after 3.30 P.M. for an hour on the third day after 3 P.M. for an hour and so on until the desired tan develops. Blondes and others who know that they cannot tan in this manner or who wish to be out in the sun without burning may do so by the application of chemical and physical light screens.

Light Screens.—The chemical light screens prevent the passage of most of the burning rays (2 900 to 3,200 Å) but permit the passage of the tanning rays (3,300 to 4 000 Å)

There are many chemical light screens on the market. They are sold under trade names and can be obtained in aqueous solution alcoholic solution oily solution and creams

Their effectiveness as screens for the burning rays varies from ten minutes for the poor ones to four hours for the best one

Quinine salol and tannic acid have long been known as chemical light screens but are now seldom used

Among the newer ones are menthyl salicylate menthyl anthranilate butyl benzal acetone oxalate b-methyl umbelliferone isobutyl para amino benzoate benzyl anthranilate and esculetin

The vegetable oils used with the chemical sun screens also have considerable screening properties chief among them are sesame cottonseed and coconut oil Mineral oil is usually mixed with these vegetable oils.

Below are suggested formulæ for suntan applications

Suntan Oil

Menthyl salicylate	10
Sesame oil	45
White mineral oil	44
Hydroquinone	0 2
Perfume	1

Suntan Cream

Menthyl anthranilat	5
Sesame oil	15
Cholesterol	2
Cold cream	28
Vanishing cream	50

Suntan Lotion

Butyl benzal acetone oxalate	2
Sesame oil	10
Tannic acid	1
Alcohol ethyl	86
Perfume	1
Hydroquinone	0 2

The physical light screens block the passage of all light rays and therefore prevent both sunburn and tanning. A cream or makeup containing 15 to 20 per cent of zinc oxide or titanium oxide or calamine will protect the skin from all sunlight Those who suffer from constitutional or skin disorders in the treatment of which sunlight is contraindicated should use physical light screens on the affected and exposed parts of the body

Urticaria.—Although this manifestation is uncommon several cases have been reported of wheals following moderate exposure to sunlight. In such cases the patients are usually found to have a history of personal or familial allergy or have been exposed to photosensitizers.

Xeroderma Pigmentosum.—This is a comparatively rare condition which is believed to be due to the action of the sun's rays upon a sensitive skin. It is distinctly a hereditary disease occurring in one or more members of the same family Although it usually begins early in life adults also have been known to develop the affection after exposure to sunlight. It is characterized by hyper pigmentation atrophic areas telangiectases, and warty and malig nant growths occurring on the uncovered surfaces of the skin. As the disease progresses, the affected skin becomes thinner producing the so-called "parchment skin In many cases malignant changes take place after several years with the formation of various types of tumor most commonly carcinoma. The clinical course of this disease is analogous to that seen in senile skin and chronic radio-dermatitis.

No treatment really eradicates this disease although the epi theliomata and other types of tumors frequently respond to roent gen-ray and radium therapy The life of the patient may be pro-longed by these measures combined with protection against sunlight.

Keloids.—These benign tumors may follow trauma of any kind They arise from scars and are usually confined to the site of the original lesion. The growths are not infrequent after heat burns and may also follow sunburn Garner reports a case of multiple linear and circular keloids in a patient from a severe sunburn with infected bullæ incurred during the previous summer Negroes are specially liable to keloids.

Epithelioma.—The comparative frequency of epithelioma on the faces of outdoor workers such as agricultural laborers sailors, and fishermen leads to a belief that it may be caused by the action of the sun's actinic rays. The course of weather-beaten (or sailors') skin can be followed through the stages of hyperemia pigmenta tion, hyperkeratosis, atrophy and finally malignant degeneration. These successive changes of the skin resemble on a reduced scale those produced by roentgen-rays Concerning the causation of epithelioma by the sun's actinic rays, some authorities consider that other causes are operative and that sunlight plays a secondary rôle. However this may be the effect of sunlight appears to be important. It is well known that although the skin develops a protective pigmentation against the sun's actinic rays, their direct action on the skin leads to atrophy Also the incidence of cancer of the face among persons who are constantly exposed to sunlight is much higher than among indoor workers. Lawrence has reported a relatively large number of cases of keratosis and epithelioma in Australia which he attributes to the action of sunlight

Fair skins are more susceptible to injury by sunlight than dark

skins and it has been observed that northern laborers working in southern climates more often suffer from keratosis and epithelioma than the natives. Negroes are seldom affected. (See "Cancer in Industry.")

Lupus Erythematosus.—This cannot be classed as an occupational disease but sunlight aggravates the condition when present, and persons suffering from it who work in the sun can develop disseminated lupus erythematosus which may be fatal.

Hydroa Æstivale.—Hydroa æstivale or hydroa vacciniforme is a recurrent vesicular disease which occurs chiefly in the summer on the exposed parts of the skin. Children and young men are most frequently affected. The cause appears to be the action of sunlight on a sensitized skin. The disease has been observed not only in the summer, but also in the winter due to the reflection of sunshine by the snow. Ehrmann has demonstrated that sunlight passed through blue glass produces this effect, but does not when passed through red glass, which absorbs the actinic rays. He therefore considers the disease to be caused by the actinic or ultra violet rays. Hematoporphyrin in the blood sensitizes the skin to the action of ultra violet rays, and porphyrins have been found in the urine of a number of patients suffering from hydroa.

Pellagra.—This is a vitamin deficiency disease with constitutional and cutaneous manifestations. The well known three D's, dermatitis, diarrhea, and dementia, are characteristic, and frequently the fourth D, death, occurs. The cutaneous eruption may consist only of slight redness, pigmentation and wrinkling of the skin. Additional lesions which may occur are vesicles, bullæ, erosions, and edema involving the lips, mouth, and other parts of the uncovered skin. A beefy tongue is frequently observed.

The disease is seen most often among field workers, especially in warm climates, who subsist on a diet lacking vitamins B_1 or G_1. It is common among mill hands in the Southern United States. Goldberger, Waring and Willets, after intensive studies, believe that the diet conducive to pellagra is that which lacks adequate proteins or other foods containing vitamin G. Nicolas and Jambon believe that the disease results largely from poverty and alcoholism.

Sunlight demonstrably exacerbates both the constitutional and the cutaneous lesions. The symptoms reach their height in the summertime, and cases have been reported of skin lesions which clear up under treatment but recur on controlled exposure to sunlight. Anderson and Ayers believe that the light sensitivity in this disease is due not to the presence of some photosensitizing chemical but to the disturbance of some light-protecting mechanism.

Artificial Ultra violet Rays.—These are produced by the electric arc, the tungsten lamp, the quartz mercury vapor lamp, and electric or acetylene welding. An exposure of one-half hour or more to a high powered electric furnace produces intense itching of the uncovered skin, and later, redness, swelling and desquamation. Exposure to the light of electric welding can cause small hemorrhages

to form under the skin. Sunburn and conjunctivitis have been reported among workmen welding rails by the electric arc. The quartz lamp is used chiefly for therapy but a burn may follow over exposure. In allergic persons urticarial wheals have been known to develop following such exposure.

Radio-dermatitis.—Physicians roentgen-ray technicians and the personnel of industries which make use of radioactive substances are affected by cutaneous changes localized on the finger-tips. The radio-dermatitis of radiologists occurs most often in the chronic form. It begins only after a number of years and is due to the cumulative effect of repeated short exposures.

The first signs are a reddish-violet color of the fingers (the thumb is seldom affected) with a sensation of fullness and sometimes of dryness. Next, the skin on the dorsa becomes thickened and inelastic and the hairs may fall or break off. The nails become fragile and show longitudinal striations, often breaking off piece by piece. The edges become hypertrophied and crack. Telangiectatic and hyperkeratotic areas appear on the skin. Ulcers often occur when the horny patches become detached and enlarge without any tendency to granulation or cicatrization. The ulcers usually become cancerous although the process is very slow the malignant growth generally appearing only after many years.

Besides this chronic form with hyperkeratoses, there may be an atrophic type. These two forms frequently coexist. Ulcers which undergo malignant change occur here also after a period of years.

Radium produces the same inflammatory processes in the skin as roentgen-rays. Depending on the severity of the burn there is edema followed by destruction of the blood-vessels elastic tissue and fibrous tissue. In third degree burns there is ulceration involving the deeper structure with sluggish healing and atrophic scarring. Telangiectases and pigmentation are characteristic. Three cases of dermatitis from radium have been reported from the laboratory of Mme Curie and a number of cases have occurred among workers who prepare products containing radium.

A chronic dermatitis caused by mesothorium was observed in a woman who worked in an incandescent mantle factory. The lesions appeared on the arms after she had been handling a 1 per cent aqueous solution of cerium and thorium nitrate for two years.

Injuries of the skin by radioactive substances are infrequent at the present time among doctors and others who use them for therapeutic work since protective measures have come to be well understood.

Radiologists are subject to a hazard due to close contact with roentgen-rays both in making radiographs and applying therapy. Workmen making the roentgen-ray tubes are exposed to the action of the rays over long periods during the process of creating a vacuum which at the same time is subjected to high-tension currents. Workmen who make electrical apparatus for radiology are exposed while making resistance tests of the high-tension generators.

Roentgenology is no longer confined to medicine but has invaded the industrial field for many purposes. It is used to sort eggs citrus fruit discover mineral adulterations in vegetable foods and find weevils in grain Defects in castings welding and reinforced concrete may be detected by the use of roentgen-rays.

X-ray dermatitis may occur in the manufacture and operation of high-vacuum electronic tubes. Although these tubes are not designed for x-ray production, they do emit x-rays and are not shielded as are the x-ray tubes. Bush Castberg *et al.** report a daily exposure of workers to as high as 2.5 roentgens. Workers should be protected by the use of sheet lead steel or lead glass.

Indications point to an ever increasing use of roentgen-rays in various processes of manufacture and distribution. Industrial workers who are called upon to handle roentgen-ray apparatus are not so well aware of the dangers as the physician and the radiologist and it is the task of the industrial physician to find means for their instruction and protection

Treatment.—In the less severe forms of dermatitis from roentgen-rays the usual treatment for dermatitis venenata may be successfully applied but in painful and persistent cases such measures may only produce exacerbation. Ormsby recommends the lead and opium wash with or without the addition of a powder glycerine, or boric acid or a mixture of this lotion and carron oil (made with olive oil) in equal parts. A paste which has proved satisfactory is made as follows

Boric acid	11 drams (46.)
Zinc oxide, starch bismuth subnitrate and olive oil	1 ounce of each (30)
Lime water and lanolin	3 ounces of each (90)
Rose water	12 drams (45)

The powder is well rubbed in a mortar and the lanolin is added and mixed the olive oil and liquor calcis are then mixed and slowly added When thoroughly mixed the rose water is put in and the whole is then beaten to a light creamy paste

Thorium X emanations incorporated in an ointment have been successful in the treatment of telangiectasia.

For deep-seated ulcers, surgery of the necrosed tissue and skin grafts are usually indicated although radium emanation ointment has proved effective in some cases. The whole leaf of the cactus, aloe vera, applied over the ulcer is recommended by Collins and Collins. The under surface of the leaf is removed so that the jelly like content which contains the active therapeutic agent may spread over the lesion Fresh leaves are applied every twelve to twenty-four hours. Pain is usually relieved in twenty-four hours, and healing takes place within two to three weeks.

* A. F Bush H T Castberg, M D H G Macpherson X-ray Exposure in Manufacture and Operation of Certain Electronic Tubes, Public Health Reports, No. 32, 1045–1047 August, 1944

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CHAPTER XI

DERMATOSES CAUSED BY INORGANIC ACIDS AND ORGANIC ACIDS

INORGANIC ACIDS

BURNS and dermatitis due to inorganic acids make up about 3 per cent of the total number of occupational dermatoses reported in the United States. *Statistics from the International Labor Office* (Geneva. Occupation and Health. 1930) state that in England in 1920 burns and dermatitis due to inorganic acids made up about 25 per cent of all accidents requiring first-aid in acid-making operations and that about 6 per cent of the total were serious in character and about 1 per cent very serious in character. In the acid-making factories inspected in the United States, the incidence of burns and dermatitis was far less, perhaps because the factories were newer and more modern, totally enclosed apparatus being used. However, in factories where the acids were used in large quantities, dermatitis and burns were more frequently found because, the acids being handled in carboys, accidents due to breakage are more common. In the oil industries where the oil is exposed in open tanks to the action of sulphuric acid and in the steel industries where the "pickling" is done in open tanks, there is also a distinct hazard from accidental splashes of acids.

Concentrated acids combine with the water in the skin and thus cause a burn. They also combine with the proteins of the skin to form albuminates. The lesions caused by acids are comparatively not as extensive or deep-seated as those caused by alkalis.

Dilute solutions of acids can cause dermatitis if allowed to remain on the skin because they become more concentrated by the evaporation of their water content. Acids entering abrasions or wounds may cause chronic ulcers.

Laboratory assistants often use acids for cleaning test tubes and other laboratory apparatus and dermatitis and ulcerations of the hands are of frequent occurrence among them.

Sulphuric Acid.—Sulphuric acid (H_2SO_4) is manufactured by burning sulphur or pyrites, forming sulphur dioxide, to which steam and oxygen are added in leaden chambers, resulting in the formation of dilute sulphuric acid, which is then concentrated. It is also made by the action of oxygen on sulphur dioxide in the presence of finely divided platinum which acts as a catalyst, forming sulphur trioxide, which is then added to water. Oleum is the name given to the highest concentration of commercial sulphuric acid.

Sulphuric acid is a heavy oily liquid having a strong affinity for water. It chars and burns the skin and attacks the clothing. Work

ers around steel and copper "pickling" tanks often have holes eaten into their clothing by splashes of this acid.[8] Sulphuric acid burns of the skin assume a dark brown or a black color. Dermatitis from dilute solutions of sulphuric acid (Fig. 8) has been reported in the felt hat industry and in the woolen textile industry where wool is treated with dilute solutions of sulphuric acid as part of the preparation of the textiles.

Sulphuric acid is used in galvanizing, pickling of metals, in the manufacture of other acids, in the manufacture of explosives and of dyestuffs, in mixtures with nitric acid for nitrations, in the refining of petroleum oils, in the making of sulphonated oils, and in many other industrial processes.

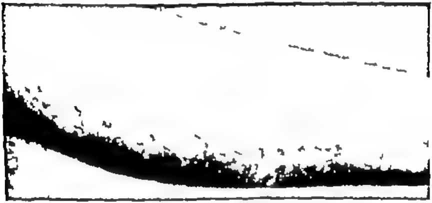

FIG. 8.—Synthetic dye worker. Filter press operator. Dermatitis due to an intermediate containing sulphuric acid.

Sulphurous acid (H_2SO_3) is not as corrosive as sulphuric acid according to R. Prosser White, causing only a slight irritation and roughness of the skin.

Nitric Acid.—Nitric acid (HNO_3) is a colorless fuming liquid which decomposes on exposure to direct sunlight, resulting in the formation of yellow nitrous oxide which imparts a yellow color to the solution.

Nitric acid is made by the action of sulphuric acid on sodium nitrate, or it can be synthesized by the oxidation of ammonia. It can also be made in the electric furnace by combining the nitrogen and the oxygen of the air.

Nitric acid stains the skin and hair a yellow color and in concentrated solution it burns the skin, forming deep ulcers which leave leathery scars. The burns are slow healing and infection of the parts are common. They should be treated by antiseptic wet dressings such as Dakin's solution or azochloramid.

Nitric acid is used in the nitration of cotton, in the manufacture of explosives and synthetic dye intermediates, in the browning of steel, and for many other manufacturing processes.

Hydrochloric Acid.—Hydrochloric acid (HCl) is a fuming colorless gas with a pungent odor. It is used in aqueous solution which contains 43 per cent of acid. Hydrochloric acid (Fig. 9) can be made by the action of sulphuric acid on sodium chloride or by burning chlorine in an atmosphere of hydrogen. It is one of the irritants which cause dermatitis and inflammation of the mucous membranes of workers engaged in soldering.

Fig. 9.—Hand of worker shoveling salt and handling hydrochloric acid. Chemical worker.

It is used as pickling agent in galvanizing, and it is also used in the preparation of chlorides, pigments, dyestuffs, in chlorinations and in medicine.

Many of the substances which before chlorination are not irritating become irritants and poisons after being chlorinated. Ceresin, naphthalene and paraffine are some of the substances which in themselves are comparatively non-irritating but become skin irritants when chlorinated.

Hydrofluoric Acid.—Hydrofluoric acid (HF) is a colorless, corrosive liquid which fumes at concentrations above 48 per cent HF. The acid has a corrosive effect upon the skin which may result in burns that are painful and difficult to heal unless properly cared for. Action of the higher strengths of this acid upon the skin is rapid and severe. The action with weaker acid is delayed and it may be several hours after contact before the burn becomes apparent. When handling any strength of this acid, any suspicious moisture on the skin should be immediately removed by washing and the area treated in order to prevent a possible burn. Fumes are very

irritating to the eyes and the mucous membranes and should be avoided. The acid will attack glass and rapidly corrode most metals

Protection to workmen handling hydrofluoric acid should include the wearing of long gauntlet synthetic rubber gloves, long aprons made of rubberized fabric rubber shoes or their equivalent, and proper goggles It is essential that this equipment be maintained in good condition Synthetic rubber gloves should be inspected frequently to insure against defects which might result in leaks

Adequate exhaust ventilation should be provided for enclosed working rooms. If such ventilation is not available a respirator of an approved type should be used avoiding however the possible collection of condensate from fumes which might result in burns on the wearer s face It is further recommended that an employee who may be exposed to fumes or acid spillage be provided with a regulation acid hood with respirator and goggles. When such a hood is used it is advisable that it be equipped for fresh air supply so that the fumes will be kept away from the face and not pocketed under the hood. Whenever an employee is exposed to dilute or concentrated fumes to the extent that cough or distress in breathing develops he should report at once to the plant physician or hospital for attention

In case acid contacts any part of the body the clothing should be stripped from the affected parts and first-aid treatment given immediately This should consist essentially of washing the affected parts liberally with cold water preferably under a safety shower until all traces of acid are removed The use of greases or salves for first-aid or emergency treatment should be avoided The employee should immediately receive medical attention For eye injuries the eye should be thoroughly washed with running water from a faucet or drinking fountain and prompt treatment given by a physician The plant physician should become familiar with the treatment of hydrofluoric acid burns. Contact of the acid or its fumes with goggles or glass spectacle lenses will etch the lenses. When this occurs they should be immediately replaced Application of a thin film of vaseline to both inside and outside surfaces of the glass will retard such etching

Porous materials that have been in contact with this acid should not be handled until they have been thoroughly neutralized with a soda ash solution. Even after neutralizing it is advisable to wear rubber gloves when handling such material

ANHYDROUS HYDROFLUORIC ACID

This grade of acid is a liquid at relatively cool temperatures but is shipped in unbrazed steel cylinders, ICC-4B (or other cylinders of superior specifications) because its boiling point (66 7° F) is often exceeded by the temperatures at which it is transported and used

Anhydrous hydrofluoric acid is used as a catalyst in the manu-

facture of high octane gasoline. It attacks lead and rubber and even many of the synthetic rubbers and plastics which are not attacked by the weaker concentrations of hydrofluoric acid.

In addition to reacting immediately with the tissue AHF will continue to destroy tissue until it has been removed. The most effective first-aid measure is the application of large quantities of tepid water. This will flush the HF from contaminated clothing as well as from the skin and will reduce injury. The treatment we use for AHF burns depends upon the removal of the acid from the tissues by prolonged soaking in water and several severe burns which we experienced responded excellently to this treatment and recovered fully. The skin after contact with AHF has a peculiar marble-white appearance. After prolonged washing with water and removal of the acid the burned area will assume a natural pinkish color and this is an indication that sufficient flushing has been given. We have found that it is necessary to apply the water for a period of three to five hours for average burns and in the case of a very severe burn water was applied after hospitalization for a total period of nearly twelve hours. Due to the necessity of treating for shock and keeping the patient in a prone position the water should be applied to the burned area through spray nozzles after the first initial shower flush of five to ten minutes, preferably longer if shock is not too severe.

Some authorities state that they have obtained excellent results by the application of a water flush followed by alternate flushing with weak ammonia and water. Others apply a special HF burn ointment containing magnesium oxide after the flushing period. Another method reported to be successful is the subcutaneous injection of 10 per cent calcium gluconate solution to precipitate the fluorine ion in an insoluble form. The whole treatment for HF burns is designed to counteract the double action of the acid, the acid action and the fluorine ion action. It is stated that the fluorine ion must be removed from the tissue to prevent deep-seated slow-healing sores and it is a matter of opinion as to which method will accomplish this best. At least the methods are all similar in that they require copious flushing with water and if this rule is followed the first aid crew cannot go wrong.

Pain is not experienced immediately on contact with the acid and in some cases does not occur until several hours later. Thus workmen may receive burns and go home at the end of their shift without knowing that they have been burned. If they are not familiar with proper treatment they may use home remedies. We have had several cases of very stubborn hard to heal burns following the application of grease or oil base home remedies to the burned area without thorough flushing. Burns under the fingernails come in this classification and may result from long exposure to strong fumes sometimes experienced by laboratory workers or from improperly washed or defective gloves. Soaking the burned hand in a basin of cold water for a long period of time will usually

give relief and the patient may even receive a full night's sleep by placing the basin alongside the bed. If these burns are not quickly recognized and soaked in water they may require removal of the nail and prolonged treatment. The calcium gluconate injection may have promise as an alternative method to removal of the nail.

Small concentrations of HF fumes in the atmosphere are easily recognized and usually cause coughing and irritation of the throat. Prolonged exposure to heavy concentrations may cause lung inflammation.

Eye burns are usually the result of a direct splash of acid in the eye and may be avoided if proper protective equipment, such as goggles, mask or face shield, is used as indicated by the safety rules. In case of an actual splash of acid in the eye, the eye should be immediately flushed with large quantities of water. Due to the clamping shut of the eyelids from involuntary muscular action, it is sometimes necessary to forcibly hold the eye open to apply the water. A bubbler fountain is ideal for flushing the injured eye. After the eye has been thoroughly washed, normal saline solution may be applied, but in all cases of eye burns it is good practice to have the man examined by a competent physician specializing in treatment of the eyes. Although fumes from HF may cause the eyes to water, actual burns from moderate exposure to the fumes are rare. The copious flow of tears has a beneficial effect in that it tends to dilute and wash away the acid.

Employees should make a practice of never unduly exposing the skin when working in the acid section and should wear full coverage of clothing at all times. Working bareheaded, with shirt sleeves rolled up or in an undershirt is exceedingly hazardous in an acid plant. Neoprene-soled shoes or rubbers, a hat or protective head covering, face mask or goggles and neoprene gauntlet-type gloves are indicated at all times. In addition a neoprene-coated apron is advisable and a complete neoprene-coated suit should be worn when repairing AHF equipment. Workmen prefer the medium weight gauntlet-type glove to the thin glove. The thin glove offers greater freedom but tears more readily and has been the cause of minor burns. Neoprene gloves should be thoroughly washed, inside and outside, and pressure tested for leaks before use. The habit of removing or raising goggles with soiled gloves should be cautioned against as it is often the cause of burns.

Skin burns, resulting in a reddening and soreness of the exposed skin area, sometimes occur from HF fumes and people who sunburn readily are more susceptible than others to burning of the skin. Thorough flushing of the reddened skin area with water, followed by the application of a soothing alkaline cream will relieve the discomfort.

Automatic safety showers should be located in strategic positions in the area where the acid is used so that they are easily accessible to workers. They should be plentifully supplied with tepid water and workers should be instructed to step under them whenever

they think that they have been splashed with acid Workers doing repairs on tanks and pipes containing hydrofluoric acid should wear full protective clothing i. e synthetic rubber suits boots gloves hats goggles and gas masks or hoods supplied with air lines leading to an uncontaminated area. Workers entering contaminated areas should be similarly clothed

Service lockers should be supplied for each operator in which to keep equipment used daily and it should be the duty of the foreman to see that this equipment is properly maintained and that replacements are made when necessary A sink with ample water supply should be provided for cleaning and washing tools.

If protective ointments are used on exposed parts of the body such as the face in areas where there is not sufficient acid fumes to necessitate the wearing of full protective clothing an ointment of the fatty type containing

Lanolin	50
Castor oil	20
Magnesium oxide	30

may be used If a dry type is preferred

Shellac	12
Linseed oil	1
Magnesium oxide	30
Isopropyl alcohol	52
Carbitol	5

can be mixed together When applied to the skin the alcohol evaporates and leaves a film of shellac in which are imbedded the other ingredients.

Dr J M Carlisle of Merck and Company treats cases of hydrofluoric acid burns in the following manner with very good results.

Cases suspected of having hydrofluoric acid on the skin are immediately treated at the suspected site by washing the part with alcohol containing ice for ten to fifteen minutes and then kept under observation The cold alcohol wash contracts the lymph channels and prevents the fluoride burn from spreading If erythema develops after this treatment the cold alcohol wash is repeated for three hours and is followed by a dressing of a paste made of magnesium carbonate and sufficient petrolatum to give the proper paste consistency (about 70 magnesium carbonate and 30 petrolatum) If breaks develop in the skin or ulcers form five parts of sulfanilamide is added to the above paste

If the eye is affected it is washed every five minutes with a 3 per cent solution of sodium thiosulfate for three hours If pain is present a drop of 1 per cent holocaine solution is instilled and an ophthalmic ointment of metycaine 4 per cent and merthiolate is applied to the eye t i d Atropine 1 per cent is instilled if the cornea is affected

Under this method of treatment there has been no necessity to

open the nails. Only if cases are not seen until several hours after the burn may it be necessary to remove the nails.

Calcium gluconate 3 to 5 per cent solution may be given subcutaneously around the border of the burns of the soft parts (never in the fingers) to check further advance of the burns.

T. A. Jones advocates repeated applications of a paste made of glycerine or liquid paraffine and magnesium oxide followed by the injection of 10 per cent sterile solution of calcium gluconate into and below the burned area where there is whitening of the skin.

The fluorides are used as insect powders, fluxes for soldering stainless steel and in laundries for removing rust stains. Dermatitis of the fingers, ulcerations under the nails and of the nasal septum may occur in workers exposed to fluorides in these occupations.

Anhydrous hydrofluoric acid is used as a catalyst in alkylating propylene, butane and pentane with isoparaffins in the manufacture of aviation gasoline.

Chromic Acid.—As a general rule the two characteristic lesions produced by chromic acid (CrO_3) are:

(a) *Chrome Holes.*—These lesions are often very deceptive in that the usual appearance is a small darkish spot surrounded by a pale area with a center ring that is the outer border of the chrome hole. In this hole is usually found pus, the walls of which are tissue undergoing necrobiosis. One of the important points here is that the lesion is usually painless because the chromic acid produces a local anesthetic effect on the tissue involved and the wound may become a third degree burn before the patient feels pain.

Treatment.—Simple palliative measures are entirely ineffective. The proper treatment is excision of the entire area of tissue undergoing necrobiosis. If this is done and in the resulting excised wound sodium thiosulfate powder is placed for a period of twenty-four hours followed by sulfathiazole powder or sulfanilamide powder, as a general rule rapid healing follows.

(b) *Perforated Nasal Septum.*—The best treatment for perforated nasal septum is prevention, since it is very seldom that it is possible to get the patient into the Medical Department before the sloughing has advanced to a point where perforation will follow. A pledget of cotton carrying some neutralizing agent that is harmless to the mucous membrane has been some protection.

Phosphoric Acid.—Phosphoric acid (H_3PO_4) is obtained by decomposing bone ash with dilute sulphuric acid. Phosphoric acid is a colorless crystal which deliquesces in the air. It is used in the preparation of various phosphates and is a skin irritant. It combines with sodium to form a number of sodium phosphates of which tribasic sodium phosphate is strongly caustic in its action on the skin. (See Alkalis.)

Phosphorous pentoxide (P_2O_5) is an odorless white solid which is extremely hygroscopic. It is a powerful dehydrating agent and skin irritant.

Prevention.—The prevention of acid burns in factories where acids are manufactured and used consists in having totally enclosed systems kept in good repair to prevent leaks and having shower baths (which work automatically the instant one steps under them) installed at many convenient places throughout the plant so that any worker splashed with acid can immediately seek relief under a shower. Sometimes it is more convenient to have bathtubs filled with water placed at convenient spots throughout the plant.

Workers who are exposed to acids in the cleaning of acid tanks or containers should wear protective goggles, gloves, clothes, boots and gas masks. Open tanks of acids such as pickling tanks should be properly vented to remove fumes and so covered at the sides as to prevent splashing of acid on the men working near them.

Treatment.—Acid burns should be immediately immersed in water to dilute the acid and then immersed in a solution of sodium bicarbonate in order to neutralize any remaining acid on the skin and then dried and treated as ordinary burns.

ORGANIC ACIDS

Acetic Acid.—Acetic acid ($CH_3CO\,OH$) can be made by the oxidation and fermentation of dilute alcoholic liquors or by the dry distillation of wood or synthetically from acetylene.

In a factory in which the latter method of manufacture is used there was considerable irritation of the nose and throat and conjunctiva noticed among the workers exposed to the fumes of acetic acid in the operation which necessitates lifting the covers from the tanks for inspection purposes. There was also seen one case of mercurial poisoning in a worker who was exposed to mercuric nitrate used in this process.

Acetic acid is one of the strongest of organic acids. It is a colorless liquid at ordinary temperatures but when solid it is known as glacial acetic acid. It has the properties of readily penetrating the tissues causing dermatitis and ulcers. Acetic acid is used in the manufacture of acetate rayon, in printing and dyeing, in finishing silk, in making acetates and esters, and in medicine. The fumes can cause irritation of the mucous membranes and dermatitis.

Carbolic Acid.—Carbolic acid (C_6H_5OH) or phenol is obtained from the middle or creosote oil distilled from tar. It can also be manufactured synthetically by the action of sulphuric acid on benzol. Pure phenol crystallizes in colorless needles melting at about 108° F. It is soluble in water but much more so in alcohol. Phenol is not only a skin irritant but a local anesthetic, so that burns from it may not be felt until serious damage has been done. It can also be absorbed from the skin and appear in the urine, to which it imparts a smoky color.

Superficial phenol burns are whitish-gray in color and are caused by the coagulating action of phenol on the proteins of the skin

but if phenol is left on the skin for a long time it can cause a black gangrene.

Phenol is used in the manufacture of bakelite and other phenol formaldehyde resins. It causes about 20 per cent of the dermatitis in this industry. It is also used in the manufacture of picric acid in the manufacture of disinfectants and in medicine. It is one of the preservatives in the creosote, or middle coal tar oil which is used for the preservation of wood and dermatitis in this industry is prevalent among those who are hypersensitive to the phenols contained in this oil.

When phenol comes in contact with the skin it should immediately be washed off with ethyl alcohol and then oil dressings applied.

The chlorinated phenols are used on wood as termite repellents and are extremely irritating to the skin. The nitrated phenols are also skin irritants and are used principally in dye and explosive manufacture.

Hydroquinone, resorcin, guaiacol, creosote, anisol, pyrogallol are also phenols which cause dermatitis. Long exposure to the fumes of creosote is said to cause brown discoloration of the skin and desquamation of the corneal epithelium.

Trinitro anisol, used as an explosive, causes yellow discoloration of the skin and a reddening of the hair.

Pyrogallol ($C_6H_3(OH)_3$) is a shining white solid obtained from gallic acid. It is a skin irritant to hypersensitive persons and is also a systemic poison. It is used as a photographic developer and as a dye for hair and furs.

Resorcinol is prepared by the action of potash on benzene disulphonic acid. In a factory where this process was used, despite totally enclosed apparatus, there occurred a case of dermatitis in a worker who was hypersensitive to even the small amount of resorcinol which managed to escape the totally enclosed process. It has also caused dermatitis when used in medicine. Mitchell reports a case of anal dermatitis resulting from resorcinol which was a constituent of some rectal suppositories.

Hydroquinone used in the photographing industry is said by Velhagen to cause keratitis and discoloration of the conjunctiva among laborers exposed to steam or dust generated during its manufacture. Paraquinone, an intermediate, is the actual irritant.

Benzoic Acid.—Benzoic acid (C_6H_5COOH) is an ingredient of various resins and as hippuric acid is found in the urine of herbivorous animals. It is made by chlorinating toluene and reacting the products with calcium hydrate.

Dermatitis occasionally occurs among workers employed in this process and is usually due to the chemicals used in producing benzoic acid and not to the acid itself. Benzoic acid occurs as white flakes with a somewhat irritating odor. While cases of dermatitis from the use of benzoic acid have not been reported, yet some of the compounds of benzoic acid have caused dermatitis. For in-

stance, the authors saw a case of dermatitis in a factory caused by benzoyl benzoic acid a dye intermediate.

Oxalic Acid.—Oxalic acid ($(COOH)_2$) occurs in Nature in certain plants especially in sorrel It is manufactured from sodium or potassium formate It is a crystalline colorless, odorless substance having a local irritating action on the skin and mucous membranes and causing a bluish discoloration and brittleness of the nails

It causes gangrenous ulcerations and if the hands are affected the nails turn blue in color and are likely to fall off leaving an ulcerated nail bed.

Oxalic acid is used in bleaching straw, hides and fabrics and is an ingredient of some shoe polishes.

Ricinoleic Acid.—Ricinoleic acid ($C_{18}H_{34}O_3$) is contained in castor oil in the form of a glyceride The acid itself is not used in industry but it is treated with sulphuric acid to form ricino sulphonic acid which is the important constituent of Turkey Red Oil used in the dyeing industry If Turkey Red Oil is properly prepared so that it has a neutral reaction it does not cause dermatitis but if it is either too acid or too alkaline it is apt to be irritating to the skin.

Schwartz has reported dermatitis among the wearers of socks where the cause was found to be an improperly prepared sulphonated castor oil which was used as a finish on the socks.

Picric Acid.—Picric acid or trinitro phenol ($(C_6H_2(NO_2)_3 OH)$) is prepared by nitrating phenol and occurs in the form of yellowish granules having a bitter taste. (See Explosives.) It was at first used as a dye but it is now used mostly as an explosive either in its pure form or in the form of its ammonium and potassium salts

Picric acid is a distinct skin irritant in the solid form but in aqueous solution it only irritates hypersensitive skins. Workers handling picric acid or its salts have the skin and hair dyed a yellowish color

Picric acid is used in medicine, in the treatment of burns and Gougerot *et al.* report two cases of dermatitis in patients where picric acid was used in the treatment of burns. In these cases a patch test with picric acid produced a hemoclastic shock.

Lactic Acid.—Lactic acid was formerly made from whey but now it is made from potato starch by the fermentative action of the bacillus of lactic acid It is a colorless liquid which will attack the skin and in strong solutions will produce an ulcer

It is used as a mordant in dyeing as a sizer in the felt hat industry where it has been reported to have caused lesions of the nails in the tanning of hides in the manufacture of lactates and in medicine

Formic Acid.—Formic acid ($H CO_2H$) is found in Nature in the sting of ants and other insects It can be manufactured synthetically by the action of sodium hydrate on carbon monoxide under heat and pressure This reaction gives sodium formate which is converted into formic acid by treating with sulphuric acid

Formic acid is a colorless liquid with a pungent odor and is irritating to the mucous membranes. It produces blisters on the

skin which tend to spread forming new ones even after exposure ceases. The vapor of formic acid will char paper is inflammable and may explode when mixed with air and ignited Formic acid burns should immediately be irrigated with a weak solution of sodium bicarbonate followed by the application of a mild ointment such as boric acid

Formic acid is used in the dyeing industry to replace acetic acid as a mordant, in the manufacture of oxalic acid and as an antiseptic in the brewing of beer and wine

Salicylic Acid.—Salicylic acid ($C_6H_4.OH\ COOH$) is prepared from sodium salicylate by the action of a mineral acid It is a white crystalline substance little soluble in water but readily soluble in alcohol It has a corrosive action on the skin.

Salicylic acid is used as a preservative in foodstuffs in the manufacture of dyes and perfumes, and in medicine

Phthalic Acid.—Phthalic acid ($C_6H_4(COOH)_2$) is a white crystalline substance which on melting is changed to phthalic anhydride It is a skin irritant to hypersensitive people and is used in the manufacture of synthetic resins and dyes.

Maleic acid ($C_4H_4O_4$) is said to be a contaminant of phthalic acid and to be even more irritating

Abietic Acid.—Abietic acid ($C_{20}H_{30}O_2$) is the chief constituent of rosin or colophony It is an irritant to hypersensitive individuals. (See Resins.)

Hydrocyanic Acid.—Hydrocyanic acid (HCN) is obtained from cyanogen compounds in illuminating gas and also from cyanides by the action of sulphuric acid. It is a colorless liquid with a smell similar to that of bitter almonds and is extremely poisonous. It is used as a fumigant for killing vermin in ships and houses and for parasites on plants

Hydrocyanic acid gas is given off in fumes from electroplating baths. Dermatitis has not been reported from the action of hydrocyanic acid gas but the cyanides are more frequent causes of dermatitis. This, however is not due to their acid reaction because most of them are alkaline. Sodium and potassium cyanides are used in case-hardening steel and also in electroplating baths. Workers exposed to the dust of the cyanides develop dermatitis of the exposed parts and ulcers of the nasal mucous membranes.

In a factory where copper cyanide was manufactured for use as a plant disinfectant the workers exposed to the dust in the grinding operations had perforations of the nasal septum Cyanides have also been described as causing a reddish coloration of the skin and hair and a rosacea-like condition of the face. Hayhurst found that cyanides used in cleaning metals in the automobile trades caused ulcers of the hands. Braddock and Tingle state that the rash occurring in the cyanide extraction of gold from ores is not due to the cyanide itself but to the strong caustic solution in which the cyanide is dissolved

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CHAPTER XII

DERMATOSES CAUSED BY ALKALIS

ALKALIS are a frequent cause of industrial dermatitis. The principal alkali irritants in industry are compounds of sodium potassium calcium and ammonium

SODIUM

Sodium is made by the electrolysis of pure dry salt The sodium collects at the cathode and the chlorine is given off at the anode Considerable heat is generated and there are frequent splashes of hot caustic material from the open cells The men who work over the cells wear goggles fireproof clothing rubber boots and gloves to protect themselves against these splashes and gas masks for protection against chlorine fumes.

The sodium is collected from the top of the cells filtered and stored in nitrogen-filled receptacles to prevent combustion The chlorine is pumped away and stored in tanks. The sludge from the sodium filters is collected and poured into molds dried and then put back into the electric cells to recover more sodium The sodium is taken off in liquid form from the filters by a vacuum pump and is poured into molds to form solid blocks called pigs The molds are cooled in oil since it is important to keep away moisture which will set sodium on fire.

The hazards in these operations are burns from fires which are quite frequent, burns by splashes of metallic sodium despite wearing fireproof clothing and dermatitis and irritation of the mucous surfaces from exposure to chlorine gas.

Sodium is used in the manufacture of silicon, magnesium sodium peroxide, sodamide, sodium cyanide and synthetic indigo

Caustic Soda (Sodium Hydroxide) – Sodium hydroxide ($NaOH$) can be made by boiling soda ash with quicklime but is now mostly manufactured by the electrolysis of brine In this process the chlorine which is generated is absorbed by slaked lime to form calcium chloride Burns are not as frequent in this operation as in the manufacture of sodium Sodium hydroxide is a powerful keratin solvent and in concentrated solution causes burns and ulcerations of the skin while in more dilute solutions it causes dermatitis.

Sodium Carbonate (Soda Ash) —Sodium carbonate (Na_2CO_3) is one of the most important commercial alkaline salts. It is found in Nature in certain rocks and is present in the waters of alkaline mineral springs. Some Californian lakes in Inyo County contain large quantities of soda Lake Magade in Uganda and many lakes in Egypt and Colombia contain large quantities of soda Sodium carbonate is also obtained from the ashes of cultivated marine

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Sodium carbonate is used in the manufacture of soap paper and glass in textile dyeing and in the manufacture of sodium salts

Workers exposed to the dust of sodium carbonate develop either ulcers or dermatitis depending on the strength of the solution which is formed on dissolving in the perspiration and on the length of time it remains on the skin. Dermatitis from sodium carbonate is more prevalent during the hot months when the skin of the workers is more exposed and perspiration is greater In the winter when more clothing is worn and there is less perspiration the incidence of dermatitis from sodium carbonate is decreased Ulceration and perforation of the nasal septum also occur among workers exposed for a long time to the dust of sodium carbonate Workers exposed to sodium carbonate often have the hair bleached to a reddish blonde. Sodium carbonate sodium peroxide and sodium perborate have a similar action on the hair

Sodium Bicarbonate.—Sodium bicarbonate ($NaHCO_3$) is used industrially for washing silk and wool The dry salt decomposes below 100° forming CO_2 and Na_2CO_3. This property has been employed by using sodium bicarbonate as a powder to separate plates of soft resin (vinyl) to keep them from sticking together and to make it easy to separate them if they do When they are heated the carbon dioxide which is formed between the plates separates them. Workers exposed to the powder between the plates develop a dermatitis caused by the sodium carbonate which remains after the carbon dioxide is given off

Sodium Peroxide.—Sodium peroxide (Na_2O_2) is made by feeding sodium "pigs" into a large inclined heated metal revolving drum The sodium first combines with oxygen to form sodium monoxide (Na_2O) a grayish powder This powder is transferred to another inclined heated drum into which oxygen is pumped and sodium peroxide is formed The sodium monoxide is put in at the upper end of the drum and at the lower end sodium peroxide is taken out The men working at this process wear moleskin gloves to prevent their moist hands from coming in contact with the sodium and ignit ing it as well as to protect their hands. They also wear fireproof protective clothing

Both sodium monoxide and peroxide are irritants to the skin and the mucous membranes, a hazard to which the workers are subjected by the dust which arises from the drums

Sodium peroxide in aqueous solution is used to bleach fabrics

Sodium Perborate ($NaBO_3.4H_2O$) is made by the reaction of sodium peroxide hydrogen peroxide and borax. Dermatitis may occur among the workers at this process from the alkaline sodium peroxide

Sodium perborate is used as a bleach for fabrics, a deodorant, a decoloring agent, and as an antiseptic in dental powders. Ulcerations of the mouth have been reported from its use in dentifrices

Tri-Sodium Phosphate (Na_3PO_4) is a good solvent of the yellowish scum and stains which form on enamelled and porcelain toilet fixtures. For this reason it is extensively used as an ingredient of

Soaps made from olive oil foots have been found to be more irritating to the skin than those made from edible olive oil

Transparent soaps are made from mixtures of decolorized tallow with vegetable oils A pale rosin glucose and glycerine may also be added Linseed oil is the chief vegetable oil used This is obtained by crushing the seeds into a meal and pressing it through hair cloth in hydraulic presses. The linseed often contains rape and mustard seeds as impurities and these oils contaminate the final product Dermatitis has been reported among workers who press linseed and is said to be due to these contaminants as well as to the mechanical cutting action of the hair filters as they are removed from the cake Linseed also contains beetle-like parasites which are said to irritate the skin.

Cocoanut oil is also extensively used in soap making It is obtained by pressing copra the dried pulp of the cocoanut Dermatitis occurs among copra handlers due to the presence of parasites in the copra These parasites do not penetrate the skin but may cause considerable pruritus and a maculopapular rash. Unrefined cocoanut oil in soap imparts an unpleasant odor to the skin It is used extensively in hard water soaps and filled soaps. It takes large additions of filling such as sodium carbonate and sodium silicate Cocoanut oil soaps are said to be more irritating to the skin than others.

Castor oil is extracted from the seeds of the *Ricinus communis* The husks of the seeds contain a poisonous substance (ricin) which does not pass into the oil but has caused dermatitis among workers who handle the seeds and the pressed cake The pressed cake on this account is not used as cattle food but as a fertilizer instead Castor oil forms a soluble soap but with a bad odor

Soap manufacture can be divided into five parts (1) Mixing in a large vat or copper kettle the fats and oils with sodium hydroxide and stirring the mixture by means of revolving arms and adding more hot sodium hydroxide until the reaction is complete Splashes of sodium hydroxide may cause burns but such accidents are infrequent. Hypersensitivity to the fats is also of rare occurrence among soap makers (2) A strong saline solution or solid salt is now added to the contents of the kettle and it is further stirred and allowed to stand until the soap is "salted out." The soap then floats on top of the alkaline liquid and this is siphoned or tapped out of the vat (3) The remaining soap is again boiled to drive off excess water (4) It is then finished by adding more dilute solution of sodium hydroxide heating and stirring to complete the saponification It is then run off from a dark portion called the niger and it is at this stage that perfumes and medicaments are added in a mixing machine called a "crutcher" to make special soaps (5) The soap is allowed to stand for a day and then transferred to cooling frames. It is then slabbed by cutting with a wire either by hand or by machine and the slabs are cut into bars of suitable size

The bars are then dried in a soap drier to remove excess water then stamped and wrapped

Liquid soaps are watery solutions, generally of a neutral coconut oil soap containing glycerine sugar or alcohol

Essence of soap and soap spirits are vegetable oil soaps dissolved in alcohol with an essential oil added for perfume

Flaked soap is made by pouring melted soap over water-cooled rotating coolers on which it immediately solidifies and removing the solidified film of soap by means of a serrated knife edge.

Chipped soap is made by cutting the dried bars of soap into chips The soap shavings are placed in shallow trays and further dried by a current of hot air The chips are then placed in a mixer where perfume and dye are added and they are then passed through a series of mills and squeezed into thin shavings. The shavings then pass through a plodding machine where they are squeezed into suitable circular bars. The bars are then cut into suitable sizes and stamped into desired shapes.

Soap Powders.—Soap powders consist of soap containing considerable percentages of sodium and potassium carbonate and sodium silicate They may also contain smaller percentages of borax perborates and sodium peroxide Special bleaching soap powders may also contain tri-sodium phosphate and sodium hypochlorite Soap powders are made by flaking the mixture of sodium carbonate and hot liquid soap on cooled rollers screening powdering and packaging These powders containing an excess of irritant alkalis are more likely to cause dermatitis than ordinary soaps.

Abrasive soaps and scouring soaps contain in addition to soap sodium carbonate sodium silicate and about 40 per cent of finely ground silica or pumice

Dermatitis is of infrequent occurrence in a modern soap-making plant where the processes are nearly all enclosed and automatic In older plants however where the workers are required to handle the materials dermatitis may occur from rancid oils and fatty acids and burns may occur from the strong alkalis. In such plants frequent change of work clothes and wearing of gloves are advocated as protective measures.

Dermatitis caused by soaps is of more frequent occurrence among dish washers scrub women soda fountain clerks housewives etc

Laundry scouring and abrasive soaps which contain added amounts of strong alkalis are the most irritating but dermatitis may also occur among hypersensitive persons from the perfumes dyes and disinfectants in toilet soaps.

Soap in the solid state contains but little free alkali The better grades of hand soaps contain about 0.2 per cent of free alkali and less than 1 per cent of alkali in the form of carbonate Laundry soaps should contain less than 1 per cent of free alkali and less than 5 per cent of carbonate Soap however is not a detergent in the solid state but in aqueous solution (the condition in which it is used) it is partially hydrolyzed into free sodium hydroxide and fatty acid

so even a soap made of virgin olive oil and soda may have in a 3 per cent aqueous solution a pH of 10

There are many theories to explain the detergent action of soap Some of these are (1) That soap emulsifies oil and the detergent action is due to this property (2) The alkali liberated by the aqueous solution of soap dissolves greasy matter (3) The alkali liberated causes water to come into intimate contact with the substance to be cleansed. (4) The colloidal fatty acid resulting from hydrolysis of soap unites with dirt or oil to form colloidal absorption compounds.

These theories all agree on the free alkali present in soap solutions and the irritating action of soap on the skin is chiefly due to the free alkali The addition of such alkalis as sodium carbonate *sodium silicate pearl ash tri-sodium phosphate etc.* increases the free alkali in the solution Free alkali has a solvent action on the keratin of the skin and also dissolves and removes its fat content tending to chap the skin and make it thin dry and cracked Such a skin is easily irritated by any external irritant and the dermatitis may result in chronic eczema. Paronychia may also be caused by soap solutions.

In order to determine which ingredient of a soap is the cause of skin irritation the following procedure is recommended

Make a 3 per cent aqueous solution of the soap and determine the pH This should not be much above 10.2 If it is as much as 10.5 the soap contains too much free alkali Patch test the patient with this solution (A normal skin can tolerate a 3 per cent solution of a virgin olive oil soap for twenty-four hours without a reaction.) If a positive reaction results patch test with a 0.5 per cent solution of sodium hydroxide, which the normal skin should withstand for twenty-four hours without a reaction. If there is a positive reaction from the solution of the soap but a negative one to the patch of 0 5 per cent NaOH solution then the patient is not hypersensitive to alkali and patch tests must be performed with proper concentrations of the other ingredients of the soap especially the disinfectants perfumes, and dyes. If these also give negative reactions, then the inference is that the soap contains an excess of free alkali.

Some of the more common perfumes used in soaps are as follows

Anise oil
Bergamot oil
Bitter almond oil
Cananga oil
Caraway oil
Cinnamon oil
Citronella oil
Clove oil
Geranium oil
Lavender oil
Peppermint oil
Rosemary oil
Safrol oil
Sassafras oil
Sweet orange blossom oil
Terpineol
Thyme oil

Some of the more common disinfectants in soaps are as follows

Phenol	Metallic peroxides and perborates
Cresol	Bleaching powders
Thymol	
Beta naphthol	

Some of the more common dyes used in soap are as follows

Red	Eosine Fuchsine Rhodamine B Cinnabar	Orange	Erio flavine Metanil yellow Orange II
Green	Ultramarine green May green Erio green Soap green Chlorophyll compound	Brown	Caramel Soap brown Erio anthracene brown R Dark ochre Fawn brown
Blue	Erio fast cyanine S.E Ultramarine blue		

Other Alkaline Compounds of Sodium.—Other alkaline compounds of sodium which cause dermatitis are

Sodium Sulphite (Na_2SO_3) used to remove chlorine from bleached cotton or paper as a food preservative and as a bleaching agent.

Sodium Sulphide (Na_2S) used in dyeing cotton with sulphur dyes, in the manufacture of dyestuffs in tanning and unhairing hides and as an ingredient of insecticides (Fig 13)

FIG. 13.—Dermatitis on arm of worker with sodium sulphide (hair-remover)

Sodium Hypochlorite ($NaOCl$) used to bleach cotton and linen

Sodium Hydrosulphite ($Na_2S_2O_4$) used to bleach textiles leather feathers, fur as a reducing agent in indigo vat dyeing and to discharge colors in printing fabrics.

These alkalis swell keratin and cause burns and maceration with discoloration of the skin Ammonium hydroxide causes similar burns, but has the added menace of its fumes which are a powerful pulmonary irritant

Treatment of alkaline burns

1 Wash immediately with fresh running water
2. Wet dressing of 1 per cent acetic acid

Salt.—Salt ($NaCl$) is found in sea water in certain inland bodies of water such as the Great Salt Lakes and the Dead Sea and in

rock deposits as rock salt. Salt is extensively used in various manufacturing processes. Dermatitis from salt and brine occurs among workers who make ice cream salt fish and in other processes where brine is used as a refrigerant. Dermatitis and nasal mucitis also occur among workers who handle salt in factories where large quantities are used for manufacturing purposes. Solid salt or salt in strong solution is a dehydrator and causes dry fissured eczemas of the palms and the back of the hands and forearms Crystals of salt may wound the skin and then cause inflammation in the wound

POTASSIUM

Potassium is made electrolytically from potassium chloride (KCl) It is manufactured in small quantities since there is no great commercial demand for it

Potassium salts are obtained chiefly from the deposits in Stassfurt Alsace and Spain. The salts of potassium are used commercially for the same purpose as the salts of sodium and their action is similar to that of the sodium salts

CALCIUM

Calcium is obtained electrolytically from calcium chloride ($CaCl_2$) and calcium fluoride (CaF_2) It is used commercially in metallurgy to remove carbon from alloys.

Quicklime or calcium oxide (CaO) is the most frequently used commercial compound of calcium It is made by heating limestone (calcium carbonate $CaCO_3$) The workers at this operation often suffer from dermatitis due to the alkaline dust. Lime is used in the manufacture of mortar cement fertilizers, soap glass, crucibles for metal smelting to remove hair from hides, in the manufacture of calcium carbide and of calcium cyanamide in the steel industry as a neutralizer of the acid used in "pickling steel and as a lubricating and drawing compound on steel It is also used as a disinfectant and as a deodorizer Workers in all these occupations may suffer from dermatitis and ulcers caused by lime

Calcium oxide actively absorbs water to form slaked lime ($Ca(OH)_2$) the reaction generating heat Slaked lime is strongly alkaline and a powerful keratin solvent When calcium oxide comes in contact with the skin and the nails, it absorbs the moisture from them and causes dermatitis or burns, depending on the quantity of lime the length of time present on the skin and the amount of moisture present Even when there is only a little moisture on the skin as in the winter time it causes chronic thickening scaling fissuring of the skin and brittleness of the nails.

Lime dermatitis often occurs among workers in glass factories (Fig 14) brick layers and men employed in the building trades. It is prevalent among leather tanners, steel workers wire drawers and also among workers engaged in the manufacture of calcium cyanide calcium cyanamide and calcium carbide

Treatment of Lime Burns.—Since the heat of solution of a single gram of calcium oxide is 18,330 calories, the particles should be removed if possible before the lime is wetted. Oil or grease or a rapid copious stream of water is used for mechanical removal of the particles. Lime burns of the eye affecting the cornea produce an opacity due to the formation of a precipitate of calcium carbonate in the cornea. If begun early and used continuously as a lavage during the first two hours, a neutral ammonium tartrate solution may prove useful in the prevention as well as the treatment of these opacities.

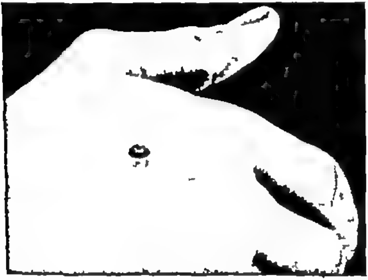

FIG. 14.—Lime ulcer on hand of hide unhairer. Leather tanning industry.

Calcium Hypochlorite.—Calcium hypochlorite ($Ca(OCl)_2$), commonly called chloride of lime, is prepared by passing chlorine through slaked lime. The reaction takes place in closed chambers which are exhausted of excess chlorine after the reaction is completed and before the chambers are opened. Calcium hypochlorite is used for bleaching fabrics, as a cleanser, and as a disinfectant. Workers in dye factories and in dye houses often use it to remove stains from the skin after work, and many cases of dermatitis attributed by the workers to the action of the dyes are in reality caused by the action of calcium hypochlorite.

Calcium hypochlorite irritates the skin not only because of its alkalinity, but also because it is a strong oxidizer. It also has a specific action on the sweat glands inducing hyperidrosis, softening of the skin, and a painful tingling sensation of the finger tips and joints. It thins the skin and makes it smooth, white, and shiny, with a tendency to crack. Sodium hypochlorite, which is less irritating, should be substituted for it.

Calcium Chloride.—Calcium chloride ($CaCl_2$) is a by-product of the manufacture of sodium hydroxide. It can also be obtained by dissolving marble in hydrochloric acid Calcium chloride is a powerful hygroscopic agent. It is used *to dry gases in freezing* solutions and for agricultural purposes It absorbs water rapidly from the skin and causes dermatitis.

Oppenheim reported the case of an ice plant worker whose feet were affected by a solution of calcium chloride which had trickled on the floor and soaked through the shoes.

Ammonium Chloride—Ammonium chloride (NH_4Cl) is prepared from the ammoniacal liquor of gas works. It has a faintly acid reaction in aqueous solutions. It is used in soldering and may cause dermatitis by the liberation of hydrochloric acid when heated with the soldering iron

Fig 15.—Dermatitis due to cyanamide— fertilizer and source of ammonia.

Calcium Cyanamide—Calcium cyanamide ($CaCN_2$) is used principally as a fertilizer and also as a source of ammonia. It is also used in the manufacture of sodium cyanide and in the preparation of cyanamide guanidine compounds and urea. Calcium cyanamide is a grayish-black powder containing a small percentage of quick lime. Dermatitis is a frequent occurrence among workers engaged in its manufacture (Fig 15)

Calcium cyanamide is made from limestone which is burned in long revolving enclosed kilns to form calcium oxide Fresh coke is mixed with the lime and fused in an electric furnace into calcium carbide The men who mix the coke and the lime are exposed to a considerable amount of lime dust and often suffer from dermatitis and lime burns.

The electric furnace in which the lime and carbon are fused is an open one and the visible hot mass in the furnace gives off an

intense blinding light The men who work around this furnace are furnished with dark glasses to protect the eyes

The hot calcium carbide containing a certain amount of lime is emptied from the bottom of the furnace into special cars and allowed to cool After the mass is cooled it is crushed into small pieces. Considerable dust which is irritating to the skin and to the mucous membrane is generated in the crushing operation causing dermatitis and ulcers among the workers around the crusher Chronic indolent ulcers are not infrequent on the hands of workers handling calcium carbide.

The crushed calcium carbide is placed in specially designed ovens and burned in an atmosphere of nitrogen forming calcium cyanamide. The cyanamide formed in the ovens is called a "pig" and weighs several tons. The "pigs" are broken up crushed into powder and stored in silos. Before it is bagged and shipped to the farmers, the calcium cyanamide is hydrated in order to slake the lime impurity and to eliminate calcium carbide and is then oiled to keep down the dust. The men who work at the crushers and automatic baggers wear respirators and protective bandages around the wrists in addition to gloves Despite these precautions, cases of dermatitis occur New workers are more likely to develop cyanamide dermatitis and cyanamide poisoning than are the old ones although occasionally old workers too have been known to become sensitized after years of immunity

About 6 per cent of the new workers in a certain large cyanamide manufacturing plant were found to develop dermatitis Some became immune after working for a time while others did not and had to be removed from this kind of work. The degree of sensitivity varied some workers developing only a mild dermatitis while a few became so sensitive that they developed a severe eczematoid dermatitis with edema of the mucous membranes after the slightest exposure to cyanamide. Removal from the work usually resulted in rapid recovery

In a factory where ammonia is made from calcium cyanamide the chemical is brought into the plant in special cars which are emptied on an enclosed platform The operation entails a great deal of dust and the men engaged in it wear respirators and protective clothing Despite this fact dermatitis and cases of poisoning occur

Systemic poisoning also occurs from the inhalation of calcium cyanamide The usual symptoms consist of headache dyspnea tachycardia, and prostration The symptoms are markedly exaggerated if alcohol in any form is taken after exposure Indeed in many cases symptoms do not develop unless alcohol is taken after exposure. A dermatitis usually accompanies systemic symptoms. In a severe case the face from the hair-line to the chin is red and swollen the eyes become inflamed the lids edematous the nose stopped up and the lips and tongue swollen. If the dust penetrates the clothing the genitals are often swollen and the skin at the waist-line and ankles where there is friction and perspiration

is markedly inflamed The dermatitis may go on to vesiculation and desquamation

Dermatitis has been reported among farmers and agriculturists who use calcium cyanamide as a fertilizer Calcium cyanamide in *the soil is decomposed either into di-cyanodiamide* ($C_2N_4H_4$) *or* into cyanamide ($NCNH_2$) Both of these substances undergo ammoniacal fermentation resulting in ammonia and calcium carbonate

Schoofs states that the irritating local effect and the specific toxic action of calcium cyanamide among workers who handle this product can be caused not only by calcium cyanamide itself but also by such volatile substances as ammonia phosphine hydrogen cyanamide and hydrogen sulphide which may be evolved during the disintegration of this substance

The prevention of cyanamide poisoning and dermatitis consists in having all dusty processes properly ventilated furnishing the men with protective clothing and respirators frequent change to clean working clothes, and compulsory shower baths after work. The workers should be warned against indulgence in alcohol and there should be frequent inspections by the plant physician.

HYDRAULIC CEMENT

Cement is essentially a mixture of lime and clay to form alkaline calcium silicate after burning

Natural cements occur in certain parts of the world The Romans used the volcanic material of Pozzuoli the terra di Santorino and the trass of the Rhine provinces for mortars to be used under water They are composed of oxides of silicon aluminum calcium magnesium iron sodium potassium and water They do not compare favorably with such artificial cements as the frequently used Portland cement

Manufacturing Process.—The principal raw materials used are limestone chalk shell rock cement (a mixture of calcium carbonate and aluminosilicic acid) clay shale Bauxite and blast furnace slag To these materials lime is added if it is desired to have a quickly hardening cement or gypsum if a slow hardening cement is desired

There are two methods of cement manufacture the dry and the wet

In the dry process the two prime ingredients clay and limestone are first dried to contain less than 5 per cent moisture in inclined rotary iron cylinders. The material enters at the top and issues at the bottom hot air being blown in from the lower end The dried material is then pulverized in totally enclosed revolving drums which contain steel balls or flint pebbles to grind the mixture to the desired consistency

In the wet process the clay and chalk or limestone are thrown together into a large brick-lined tank. Water is added and the mass is mixed by rotating arms which revolve in the tank. A slurry or paste is formed which flows away in a continuous stream

into another tank where it is further mixed This paste may be dried into a form of a brick or if it contains little water it can be directly put into the burning kilns.

The burning kilns are stack-like structures in which the cement is fired with a coal or it can be the more modern slowly revolving inclined steel cylinder lined with brick. The cement enters at the top travels down the cylinder and meets the heat and flame of burning petroleum or pulverized coal blown into the lower end The material is discharged white hot as clinkers which fall into a cooling cylinder located under the revolving kiln.

The cooled clinkers are conveyed to enclosed grinders which pulverize them to the proper fineness Gypsum or lime necessary to retard or hasten the setting qualities of cement is added before the final pulverization

The finished cement is conveyed by belts or elevators to the storage bins. From these it is brought down by conveyors to automatic weighing machines and placed in special bags which are filled from the bottom through valves to create a minimum of dust.

The slag of blast furnaces composed of the silicates of calcium and aluminum is also used to make cement It is mixed and ground with lime and then burned as described for Portland cement

Roman cement is made by calcimining a clayey chalk with silica

Mortar is a mixture of cement sand, and water

Action of Cement on the Skin.—The hygroscopic properties and the alkaline content of cement are the chief causes of its irritant action on the skin The more lime a cement contains, the more irritating its action on the skin. The grains of silica which it contains may also irritate the skin mechanically

Upon adding water to cement the lime which it contains is slaked to form calcium hydroxide generating heat This is the most active irritant although the calcium silicate itself is alkaline and plays a part in causing dermatitis When cement with little moisture content comes in contact with the skin it absorbs moisture from it and after some time causes the skin to become dry hard and thickened. Such skin is likely to crack and result in fissures and indolent ulcers

Cement causes the nails to become dry and brittle. It also causes chronic conjunctivitis blepharitis and ulcers of the nasal and buccal mucous membrane Among workers who perspire freely cement is likely to cause dermatitis first on the exposed parts and later on the covered parts of the body For this reason, dermatitis from cement is more common in hot than in cold weather

Wet cement may have the same action on the skin. For this reason, acute dermatitis due to cement occurs more frequently among mixers of concrete and bricklayers than among workers who handle dry cement or are engaged in its manufacture.

Frequency of Occurrence.—In Occupation and Health International Labor Office Geneva 1930 Berger and Helwar reported that during the years 1892 to 1899 10 per cent of the cement workers

in Germany suffered with dermatitis or cement itch In Russia in 1925 an inquiry in the cement factory of Erinsk showed 18.2 per cent of the workers had been affected with dermatitis over a period of two years. Koelsch found that 30.3 per cent of 600 cement workers had inflammation of the nasal mucous membranes. Two per cent had ulcerations and about 1 7 per cent had perforations of the nasal septum.

Tome Bona and M Javier state that about 2 per cent of all the illness in the building trades is due to cement dermatitis. They describe three types of skin lesions caused by cement The first consists of vesicles and pustules with edema on the hands, fingers and other exposed parts of the body It is most prevalent in hot

Fig 16.—Cement dermatitis—concrete worker

weather among workers who perspire freely The second type consists of a softening and thinning of the epidermis which results in painful swelling of the palms and fingers. The third type is a hyperemia and folliculitis which usually occurs on the back and upper thorax of workers who carry bags of cement on their backs (Fig 16) They also describe lesions of the upper respiratory mucous membranes especially ulceration of the mucosa of the cheeks

In the United States Thompson *et al* (Health of Workers in a Portland Cement Plant *U S Public Health Bulletin* No 176 1928) found only 37 cases of disabling skin diseases in the course of three years among 743 cement workers and most of these were cases of furunculosis.

Russell examined 570 cement workers and stated that diseases of

the skin caused a high rate of disability He stated that furunculosis was the cause of 70 per cent of these disabling skin diseases.

The differences in the observations of various writers may well be due to the differences in the sanitary and safety measures adopted in the different cement plants studied

Murero states that the rapid setting cements cause dermatitis more frequently than do the ordinary ones, and that workers who can handle ordinary cement with safety often develop dermatitis when they work with rapid setting cements. He attributes this to the larger percentage of lime contained in rapid setting cement

Cohen and Ganot (*Bull. Soc franc. de dermat. et syph.* p 1135 July 1931) described a true allergic cement dermatitis in which a patch test with cement not only gave a positive reaction in a few hours, but also a hemoclastic crisis as manifested by a fall in blood pressure and a rise of the leukocytes.

Prevention.—The prevention of dermatitis among workers in cement manufacture consists essentially in dust control and cleanliness of the workers.

Modern totally enclosed machinery and modern methods of general ventilation with local suction vents over such dusty processes as barrelling and bagging go a long way towards the prevention of dermatitis. Compulsory shower baths after work and the daily change to clean work clothes further reduces the incidence of dermatitis.

Those inclined to develop dryness and cracking of the skin should wear gloves while working They should rub lanolin into the skin before putting on the gloves and also before retiring to sleep Those who develop dermatitis should be taken off the work and given treatment until they recover Those who continue to have acute attacks of dermatitis on resuming work or who have chronic eczemas, should be moved to some other occupation.

The eyes can be protected by wearing goggles and by bathing them in boric acid solution after work.

The mucous membranes of the nose and throat can be protected by respirators. In addition to this a mild boric acid ointment with a lanolin base can be inserted into the nostrils to coat the cartilaginous portion of the nasal septum the most common site of ulcers and perforation

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CHAPTER XIII

DERMATOSES CAUSED BY METALS

A NUMBER of metals used in industry are capable of causing dermatitis either in the metallic form or in some of their compounds For example metallic mercury can produce dermatitis but platinum is not irritating to the skin except as platinum chloride or oxide. Other metals and their salts may be innocuous but dermatitis often occurs from substances used in their production Such is the case with iron and steel in the process of refining the lime phosphorus, sulphuric acid etc which are used or liberated may cause dermatitis. (See chapter on Iron and Steel Manufacture.)

Aluminum.—The salts are very astringent Immersion of the hands in alum solutions can cause the deposition of aluminum hydrated oxide which hardens and tans the skin and produces a tendency to crack. Aluminum salts used in deodorants have been responsible for cases of dermatitis. (See Cosmetics.)

Antimony—Antimony and its compounds are used in numerous industries and for a variety of purposes. It is occasionally found in its pure state but more often as stibnite (Sb_2S_3) or trisulphide of antimony It is obtained from its ores by roasting in furnaces oxidation and then reduction to the metallic state

Metallic antimony is used to manufacture antimony salts and fireworks to make metal alloys with lead tin and copper for printing type, antifriction metal dental work, grids for electric storage-battery plates and metals for decorative objects and furniture trimmings to color varnishes glass terra cotta and prepare aniline colors (instead of arsenic) The precipitated form known as *antimony black* is used to produce the appearance of polished steel on papier maché and pottery

Occupational dermatitis from metallic antimony is rare In a plant visited by the author where antimony compounds are manufactured no cases of dermatitis have been seen. However most of the processes in this plant are totally enclosed. For chlorination *metallic antimony is first crushed into small pieces. The workers* who perform this process inhale the dust and some of them develop diarrhea as a result.

Thomas Oliver in 1904 stated that antimony smelters suffered from pruritus erythema and vesicles which are likely to become pustular The areas involved were the head beard eyelids, nails lips and nostrils. When the powder penetrated the clothes, however the flexures of the body were chiefly affected These conditions were thought to be due to arsenic as a contaminant

Meyer and Gottlieb state that local contact with antimony and its compounds causes eruptions of the skin characterized by peculiar small pustules which resemble those of smallpox These are situ

ated around the sweat and sebaceous glands and are often accompanied by marked sweating The authors say that it causes the death of cells by necrosis in the same way as arsenic R. Prosser White notes that in the presence of even a slight abrasion antimony like potassium cyanide and bichromate and lime may produce an obstinate ulcer

Antimony may also cause chronic poisoning Some cases have been observed among miners and smelters of stibnite. This occurs when the furnaces are defective and during the pulverization of stibnite or pure antimony It is also seen among workers who put the oxide drawn from condensing chambers into sacks, and among those who clean these chambers. Stomatitis is sometimes found and is similar to that seen in lead or arsenic poisoning (See Diseases of the Mouth.) There is no certainty that these symptoms are solely due to antimony because of its frequent contamination with other metals Koelsch is quoted as describing the line on the gums due to antimony poisoning to be of a reddish-brown color tending towards deep violet Salivation is as abundant as in mercurial stomatitis Eczema sometimes accompanies chronic poisoning

Hamilton reports two cases of eczema of the hands and forearms caused by antimony among workers at the melting-pots used for type.

Compounds of antimony most used in industry are the trichloride trioxide, pentasulphide and tartar emetic.

Antimony Trichloride ($SbCl_3$) —Antimony chloride (butter of antimony) is formed by dissolving the oxide or sulphide in concentrated hydrochloric acid The solution is evaporated and the antimony trichloride is then distilled.

It is used in the manufacture of antimony salts, tartar emetic lakes and dyes as a catalyst in organic synthesis as a mordant for fixing colors on fabrics in calico printing and to dye furs and textiles for antimony electroplating bronzing iron, and burnishing metal articles such as firearms, and to color zinc black for fireproofing and in medicine.

The dust or fumes cause keratitis. Inhalation also causes irritation and excoriation of the mucous membrane of the mouth and throat, burning pains in the mouth and pharynx, swelling and vesiculation of the lips, and increased salivation

The authors have observed ulceration of the nasal septum caused by the dust.

Antimony Trioxide (Sb_2O_3) is found in Nature as senarmontite or as flowers of antimony It is prepared by oxidizing antimony with a limited quantity of air steam or dilute nitric acid.

It is used in the manufacture of antimony salts, enamels for cast iron paint pigments, and tartar emetic to decolorize and refine glass as a mordant in dyeing and printing textiles to produce blacks in cadmium and zinc and in medicine It is also used as a substitute for white lead

Oliver states that large quantities of the trioxide in powder form set up a minute pustular dermatitis if the skin is damp with sweat but he concludes that it presents no serious industrial hygienic problem.

Antimony Pentasulphide (Sb_2S_5) (golden antimony sulphide) is obtained from a weak acid solution of antimonic acid and hydrogen sulphide or by treating a weak solution of thioantimonate with dilute hydrochloric or sulphuric acid hydrogen sulphide being formed simultaneously

It is used in the manufacture of matches and fireworks, as a pigment for coloring metals, and in antimony plating It is also used as an accelerator in vulcanizing and coloring rubber

According to Quinby it causes dermatitis.

Antimony Tartrate (tartar emetic, or potassium antimonyl tartrate) is used in medicine and as a mordant in dyeing cotton with basic dyes.

Cellisky described itching papules, and pustules among cotton printers from this substance. The wearing of a fur for dyeing which the salt was used as a mordant has been reported to have caused dermatitis.

Other antimony compounds used in industry are the oxychloride the pentachloride and the trisulphide No dermatitis has been reported due to these substances.

Arsenic.—This chemical is used in preserving furs feathers, skin, to decolorize glass and crystal for black and green bronzing insecticides and fungicides. It is given off in lead smelting and also in certain other manufacturing processes

The manufacture of arsenic trichloride causes ulceration and dermatitis of exposed parts and irritation of mucous membranes Ulceration of the nasal septum occurs from the dust of arsenic trioxide among the makers of Scheele's green, Airmen scattering insecticide (arsenate of lead) and those spreading calcium arsenate to destroy locusts. (See Insecticides.)

Barium.—Barium is not used as a metal in industry but its salts are employed for various purposes. In the manufacture of Véry lights, the workers have suffered bleaching of the hair and epilation The sulphide and sulphate used in depilatories may be responsible for dermatitis and deep ulcers. Salts of barium are also used in the tanning of hides in photography and as an ingredient of bleaching powders.

Beryllium is used as an alloy with aluminum and other light metals. The melting of beryl from which it is derived liberates hydrofluoric acid fumes that cause eruptions of the skin Beryllium fluoride causes dermatitis.

Bismuth.—This metal is almost always associated with sulphur iron nickel copper cobalt antimony and silver and contains small amounts of foreign substances even after purification. Bismuth is employed in the preparation of metal alloys and the sub-

nitrate is an ingredient of some cosmetic preparations where it acts as a cutaneous irritant. (See Cosmetics.)

Cadmium.—Cadmium is a somewhat soft white metal obtained by roasting some of the zinc ores which contain it. It distills before the zinc.

Metallic cadmium is used in the preparation of welding materials and more recently in cadmium electroplating. Cadmium sulphide is used in the preparation of cadmium yellow, a color resistant to the action of light. Cadmium iodide is used in medicine and in photography.

Cases of systemic poisoning from cadmium have been reported in Germany and England. The symptoms consist of weakness, lack of appetite, nausea, irritation of the conjunctiva and the mucous membranes of the respiratory tract. The urine has a brown color and autopsy of a fatal case showed fatty degeneration of the heart and liver, hemorrhagic inflammation of the spleen and inflammation of the kidneys. No cases have been reported in the United States.

Calcium.—Calcium is of no industrial importance as a metal but the oxide (lime) and other compounds are caustic irritants. (See Alkalis.)

Chromium.—The salts of chromic acid produce dermatitis and ulceration. (See Chromic Acid and the Chromates.)

Cobalt.—Arsenical compounds of cobalt have caused localized dermatitis, especially of the genitals, among workmen who roast cobalt ore containing arsenic. Hyperkeratosis of the palms with small erosions of the skin has been observed among workers who wash the ore and is due to pressure from the tools and the forcing-in of particles of ore. Oppenheim has reported eruptions of the skin among women engaged in gilding which he considers possibly due to cobalt dust. Among English cobalt miners, there is a high incidence of pulmonary cancer the etiology of which is uncertain.

Dermatitis in a factory making an alloy of cobalt was shown by patch tests to be due to allergy to the dust of metallic cobalt. Asthma caused by cobalt dust also affected some of the workers. Cobalt is used in the preparation of certain kinds of steel and alloys, anodes for electrolysis of alkaline electrolytes, nickeling other metals, colors, enamels, and certain kinds of glass. The chloride is an ingredient of the adhesive mixture used for some fly papers and of some hair dyes.

Copper.—Copper dust causes a greenish-black discoloration of the hair of smelters and other exposed workers. The dust of copper precipitate also causes a dermatitis ("copper itch") in the production of which the presence of arsenic is believed to be a factor. Sore throat and gastro-intestinal disorders have been observed occasionally in copper founders engaged in crushing and melting ore containing selenium. (See Selenium, p. 196.)

Gold.—The metal is non-toxic but dermatitis occurs from other sources in the course of treating gold. (See Jewelry and Allied

Industries.) Gold chloride is said to cause dermatitis among photographers who use it in their work.

Iron and Steel.—Iron ore often contains arsenic and sulphur which are removed before the iron is extracted. This is done by roasting the ore. The ore is then mixed with "flux" which may consist of ground quartz, sand, or limestone with a small amount of aluminum oxide, and the mixture is charged into the top of a blast furnace. (A blast furnace is a metal structure shaped like two cones with bases together, lined with fire-resisting brick or clay.) The fire in the blast furnace is first started and on top of a layer of coke is poured the first layer of the ore mixture. On top of this is poured a layer of coke and on top of this is poured a layer of ore mixture and so on, until the furnace is fully charged. The heat of the furnace causes the CO, which is evolved from the burning coke, to reduce the iron ore to metallic iron, which melts and settles to the bottom or crucible of the furnace. The slag floating on top of the iron in the crucible is removed and cooled. When the crucible is full, the iron is run off from the bottom into "ladles" and poured into molds to form "pigs."

Steel is made principally in open hearth furnaces or by the Bessemer process.

The open hearth furnace allows the use of scrap iron, cast iron and ore mixtures in making steel. Iron ore, steel scrap, lime, sand, coke and alumina are mixed in proper proportions in an iron trough which is emptied into the furnace by means of a ram.

The men who mix the materials which go into the furnace sometimes develop dermatitis, usually from the lime which is put into the charge. The hands, fingers and wrists are usually affected with an erythematous, papular, vesicular eruption.

The men who attend the furnace wear dark glasses to protect the eyes from the brightness and heat of the glowing mass when they look into the furnace which is necessary to charge and inspect during the course of the operation. Inspection of the mass is done through small doors which are opened only during the period of inspection.

The molten steel is discharged from the bottom of the furnace into a brick-lined receptacle called a "ladle." The ladle is lifted by a crane and its contents emptied into cast iron molds. The sides of the molds are sprayed with lime, graphite, carbon or sugar before the molten steel is poured in. These substances act as lubricants and prevent the molten steel from adhering to the molds. The steel in the molds is allowed to cool, and when it is taken out it is called an "ingot."

The Bessemer steel process consists of passing a strong blast of compressed air through molten cast iron. The reaction takes place in a pear-shaped iron container called a "converter," and is lined with silicous fire clay. The converter can be revolved and tilted to discharge the molten metal into suitable molds. The converter is charged with molten cast iron and a jet of air is passed through the liquid mass. This causes increased combustion of the silicon

manganese carbon phosphorus and iron in the mass and increases the temperature, causing flames sparks, and explosions to come from the mouth of the converter After the reaction is completed as is shown by the issuing flame becoming smaller steadier and brighter and by a continuous spectrum (spectroscopic readings of the reaction are taken) other iron alloys such as ferro-carbon and ferro-manganese can be added to make the required kind of steel After a few minutes the finished alloy is ready to be poured into molds.

Outside of accidental burns there are no skin hazards connected with this operation The men who work around the converters wear dark glasses for protection against the brightness and heat of molten steel.

Alloy steels are also made by mixing definite quantities of the elements to be used with the cast iron before it goes into the furnace. The principal alloy steels contain silicon, manganese, vanadium chromium, molybdenum tungsten nickel, and combinations of these elements.

The ingots taken from the molds are reheated to a white heat and are run through rolling machines for reduction in size After passing through a series of such machines they come out in the form of square bars or plates.

Intertrigo is prevalent among workers around the furnaces and hot metals. The excessive perspiration macerates the skin of the axilla and groin. Frequent change to dry clothes, the use of powders such as stearate of zinc, and daily cleansing baths are recommended as preventive measures.

Wire Drawing —Bars of steel from the rolling mills are heated to a white heat and reduced in size by passing through pressure rollers. They emerge cylindrical in shape and are known as "rods.

The rods are allowed to cool then immersed in sulphuric acid solution and after a few minutes lifted out and cleaned by immersion in a tank of water They are then lifted out of the water and placed in a tank containing a strong solution of lime. After being lifted out of this tank, they are placed in a drying chamber This whole process is called "pickling Workers at this operation are subject to dermatitis and burns from splashes of acid and lime.

When the rods are taken out of the driers they are coated with a white deposit of lime which acts as a lubricant in the drawing operation.

The rod ends are threaded and drawn through a series of dies diminishing in diameter until the desired diameter of wire is attained. Various lubricants such as soap aluminum stearate and suet, in addition to the lime are used on the wire as it is being drawn The workers at this operation are known as wire drawers. They wear safety goggles to prevent eye injuries from snapping wires and also leather gloves or leather palm pads to protect the hands Despite these precautions dermatitis is of frequent occurrence especially among those wearing gloves and is caused by the lime drop-

ping in the gloves and being slaked there by the perspiration Soap powder can have a similar effect. Palm pads are better to wear since they can be tied around the wrist and brought up against the palms when wire is handled

In a wire drawing factory where gloves were worn about 5 per cent of the wire drawers developed dermatitis.

Copper is drawn into wire in a similar manner except that in pickling copper the lime dip is omitted and the lubricant on the wire is beef fat.

Lublinski found that 27 per cent of the wire drawers in a Russian factory had vesicular scaling lichenoid eruptions of the hands and forearms with swelling fissures and deep-seated vesicles of the palms He attributed these lesions to contact with the sulphuric acid of the pickling solution and to prolonged contact with the fat used as a lubricant, as well as to local hyperhidrosis.

In a factory in the United States where copper wire was drawn an outbreak of dermatitis occurred among workers who coated the wire with rubber Our investigation showed that the dermatitis occurred among those who handled the hot uncured rubber Dermatitis was due to hypersensitivity to the accelerators used in the rubber The accelerators consisted of aerin thionex and diorthotolyl guanidine which were used in excessive amounts.

Wire is also insulated by coating with chloronaphthalenes chlorodiphenyls chlorodiphenyloxide tar pitch rubber both natural and synthetic, vinylite vinyl carbazole and other synthetic resins. An acne-form dermatitis may occur among those handling wire insulated with the chloronaphthalenes chlorodiphenyls chlorodiphenyloxides, and tar An eczematoid dermatitis may occur but is rare from vinylite and rubber insulation Vinyl carbazole is a strong sensitizer and dermatitis is of frequent occurrence among those who work with it

Dermatitis occurs among workers who handle pickled steel used in the manufacture of other articles. An outbreak of dermatitis among tack makers was found to be due to an excessive amount of lime on the steel plates from which the tacks were made.

Dermatitis occurs frequently among workers who machine steel In punching drilling and cutting operations cutting oil compounds are run in a continuous stream over the operations to cool the steel and preserve the tools These cause dermatitis. (See Cutting Oils.)

Steel workers often wrap friction or adhesive tape around the fingers to protect them from trauma. This practice has often resulted in dermatitis due to the irritants in the tape

An outbreak of dermatitis among workers in a nut and bolt plant was found to be due to the reclaimed rubber in the friction tape used around the fingers.

Similar cases of dermatitis occurred among girls who used adhesive tape to protect their fingers against the fuse wires in a blasting cap factory

Heat Treatment of Steel.—This is done for the purpose of hardening it. If only the outside of the steel is to be hardened it is called "case hardening" Case hardening is done by placing the piece in a bath of a molten chemical such as sodium cyanide or sodium nitrite or a mixture of sodium cyanide and sodium carbonate, or a mixture of sodium nitrite and sodium dichromate. The temperature of the molten mass is around 800° F and the metal is allowed to stay in it for a sufficient time, and then taken out and plunged into quenching oil or into water The molten salt is in an enclosed pot covered with an exhaust hood to draw away fumes. However the cyanide and sodium carbonate fumes solidify as they strike the cooler surfaces of the sides of the enclosure and the workers may develop dermatitis, especially as the skin is hot and perspiring from the nearness to the molten salt when the steel is inserted and taken out. Ulceration of the nasal mucosa may also occur The dust around the ovens is mostly sodium carbonate into which the sodium cyanide is converted by oxidation. Sometimes the hot oil may spatter and burn the skin The hot water containing cyanide sodium carbonate sodium dichromate or nitrite coming off the hot metal may splash on the foot and legs and cause dermatitis

When the steel is to be hardened throughout it is heated in ovens at 1000° F for an hour or so and then plunged into quenching oil.

Workers at case hardening should wash the hands immediately after handling the irritant salts. They should wear leather gloves, leather aprons and rubber boots. They should insert petroleum jelly into the nostrils several times a day to prevent nasal ulceration or wear respirators. They should wear safety goggles to protect the eyes.

Rust Proofing Steel.—(See also Electroplating) Many chemicals are used to prevent steel from rusting Synthetic resin coatings and petroleum oils and greases used as rust preventives sometimes cause dermatitis. The wearing of fabric or leather gloves will prevent this, especially if an oil repellent protective ointment is applied to the hands before putting on the gloves.

Steel is sometimes "browned" to prevent rusting The barrels of rifles and shot guns are treated with nitric acid burns and dermatitis often result.

Small steel parts are sometimes treated with a strong solution of caustic soda in order to make them rust proof Burns and dermatitis occurs in this operation Rubber gloves should be worn in handling strong acids and caustics. Various methods of rust proofing in which chromic acid and chromates are used are called Parkerizing Anodizing Chromadizing etc

Metal parts are degreased by immersion in a petroleum solvent or by exposure in a tank to the vapor of trichlorethylene If the hands are wet with the petroleum solvent dermatitis often occurs. The use of oil resistant gloves (synthetic rubber or polyvinyl alcohol) over hands covered with an oil repellent ointment is a good preventive Properly constructed trichlorethylene degreasing tanks

present but little dermatitis hazards. Occasionally a case of dermatitis occurs if the vapors are permitted to escape from the tank.

Galvanizing.—The iron is run through a bath of a mixture of molten tin, lead and zinc chloride. Dermatitis and nasal mucitis may occur among workers from the fumes of zinc chloride.

When galvanized iron is welded the fumes of zinc can cause dermatitis and nasal mucitis.

Carburizing.—Carburizing is a method of hardening steel by heating it in a packing of peach stones and soda ash contained in chrome nickel steel pots. Dermatitis may arise from the alkali among workers filling the pots and from alkali chromates and cyanides when the pots are opened after being taken out of the ovens. Workers at carburizing should wear leather gloves, leather aprons and long sleeves.

Testing Metals for Flaws.—Parts made of metals are tested for flaws in the following manner:

1. X-rays are used for detecting flaws in large pieces of iron and steel. The workers are well shielded from the rays but nevertheless the hazard of x-ray burns is present from accidental defective shielding. It would be well to do differential leukocyte counts on all workers at this operation every six months.

2. The magna flux is an apparatus used to detect flaws in small iron or steel parts. The parts are immersed in a petroleum solvent containing iron filings and when the current is turned on and the parts lifted out of the solvent the flaws are seen because of the iron deposited in them. The skin hazard in this operation is from the solvent into which the hand is immersed to lift out the parts. Workers on this job should wear solvent proof gloves either of synthetic rubber or polyvinyl alcohol.

3. Flaws in metals can also be detected by immersing them in a solution of a fluorescent dye like eosin, and looking at them in a dark room. The fluoresence shows in the flaws. The hazard in this operation is allergic dermatitis and photosensitivity from the dye.

4. Brass parts are examined for superficial flaws by dipping them in a solution of mercurous nitrate. The flaws are seen as grayish lines. Mercurous nitrate is a skin irritant.

In all the testing for flaws operations workers should be protected from the irritant chemicals by wearing impervious sleeves, aprons and gloves.

Magnesium.—This metal is extensively used in the manufacture of airplanes. The crank cases of motors are made of magnesium and the wings and fuselages contain Dow metal, an alloy of magnesium. Metallic magnesium buried in the tissues may generate hydrogen and cause gas gangrene but the authors have not observed such cases in their factory inspections.

Burns are of frequent occurrence among those engaged in casting magnesium. They are slow to heal. Metallic magnesium should

be removed from the wound as soon as possible to prevent formation of gas tumors and pneumogranuloma.

The molds for magnesium metal contain sulfur ammonium acid fluoride, ammonium borofluoride boric acid petroleum oils and lycopodium The fluorides and the sulfur are added in the proportion of a 4 per cent to the new molding sand for the purpose of inhibiting magnesium flames. Considerable dermatitis occurs especially in the summer time among workers mixing the molding sand. This undoubtedly is due to the fluoride content. Nosebleed occurs among men working with the sand molds and also among workers pouring molten magnesium This, undoubtedly is due to the fluorides given off when the hot magnesium is poured into the sand molds containing the fluorides.

Cores for castings contain fluorides sulfur bentonite corn flour and core oil, a mixture of mineral animal and vegetable oils. The parting compound is wax dissolved in a solvent. Workers handling core sand should wear thin washable gloves similar to chamois in order to prevent contact of the fluorides with the skin. These gloves should be frequently washed to remove fluorides. Those workers who show a tendency to develop dermatitis from core sand should either be removed from the operation or provided with impervious sleeves and aprons as well as the chamois gloves. All workers exposed to fluoride fumes should insert a petroleum jelly into the nostrils two or three times a day to prevent irritation of the nasal mucosa.

MERCURY AND ITS COMPOUNDS

Statistical

Statistics reported by the Connecticut State Board of Health covering a period from June 1930 to July 1933 showed 117 cases of dermatitis due to mercury out of 818 cases of dermatitis from all occupational causes. Connecticut was, and is the center of the felt hat manufacturing industry in which *mercury nitrate* is used Presumably there was also a number of mild cases of mercury dermatitis that were not reported

In Europe the International Labor Office reported that one-half (13) of the persons examined in two pastille factories in Bavaria showed symptoms of mercury poisoning with blackened teeth stomatitis and dermatitis of the fingers due to contact with *mercury bichloride*

Statistics quoted from Great Britain and France did not distinguish between systemic poisoning and dermatitis due to mercury The various occupations in which 229 cases of injury by mercury were reported from 1899 to 1923 by the Medical Inspector of Great Britain were as follows 52 in the manufacture of explosives (mercury fulminate) 47 in making thermometers 25 among hatters and furriers 25 in making electric meters 23 in manufacturing felt

hats 21 in the manufacture of chemicals 8 in watergilding 4 in making mercury lamps 3 in bronzing 2 in photogravure work and 19 in miscellaneous occupations. Between 1924 and 1930 a total of 24 cases was reported.

From 1922 to 1927 37 cases were recorded in France. Of these 21 were in the haircutting and carroting industry 7 in hatters and furriers processes, 14 in thermometer making and 1 each in the hat industry industrial photography drug (ointment) industry electric battery manufacture (zinc amalgam) and iron-nickel battery manufacture

Mercury is made from the natural sulphide by roasting the ore the sulphur coming off as sulphur dioxide or by heating the ore mixed with lime in closed retorts In the second process the lime combines with the sulphur while the mercury is liberated and distills over as vapor which is then condensed Mercury readily combines with many other metals to form alloys or amalgams.

Mercury is used in the metallic state and in the form of compounds. The compounds which are derivatives of the mono- or bi-valent oxides are generally prepared either by a dry or a wet method

In all its forms mercury may produce dermatitis or systemic poisoning It constitutes a hazard in numerous industrial processes chief among which are the following

- Handling the mercury ore.
- Extraction of silver and gold from ores.
- Manipulation of mercury in chemical laboratories.
- Filtration of mercury
- Distillation of mercury
- Heating of amalgams of silver or gold for recovery of precious metals.
- Treatment by heat of amalgams by dental mechanics and dentists.
- Use of alloys with tin and copper containing about 5 per cent of mercury
- Amalgamation of zinc in factories making accumulators and electrodes.
- Electrolytic preparation of chlorine (cathode of Hg)
- Preparation and use of lead mercury solder (used during the war)
- Recuperation of sulphuric acid by mercury
- Manufacture of electric meters.
- Manufacture and repair of storage batteries with mercury (zinc amalgam and iron-nickel)
- Manufacture of various electrical appliances.
- Photogravure work.
- Etching on steel.
- Industrial photography
- Goldsmithing
- Mirror making

Hot gilding
Insecticide manufacture.
Anti-mildewing or tropicalization
Gilding silvering and tinning by means of mercury
Bronzing and damascening by use of mercury salts.
Manufacture of scientific instruments such as barometers, thermometers mercury switches mercury vapor lamps and freezing machines
Manufacture and use of mercury pumps (not common at present)
Manufacture of incandescent and radiographic lamps with mercury pump
Manufacture of mercury compounds (nitrate chloride cyanide)
Manufacture of salts of mercury especially by the dry method
Manufacture of mercury products with mercury as a base
Manufacture of vermilion red colors with mercury
Manufacture of synthetic alcohol and acetylene as starting point. (War industry use of mercuric sulphate as a catalyst)
Manufacture of acetone (with formation of mercuric oxide and regeneration of mercury in a closed cycle)
Treatment of furs and skins with salts of mercury
Carroting of skins with acid nitrate of mercury (preparation of raw material for felt hat industry)
Felting of carroted hair
Taxidermy preserving the skins (mercuric chloride)
Manufacture of fireworks.
Artificial silk industry
Printing trades.
Manufacture of cartridges and primers with mercury fulminate
Generation of power
Anti-fouling paints applied to ships bottoms (red mercuric oxide)
Pharmacological work
Medical work.

The local action of mercuric salts on the skin is corrosive and irritating. A solution of as little as 1 part in 2,000 or even 4,000 parts of water can be very irritating to the unbroken skin. Among the newly employed, contact often produces dermatitis.

If the skin is cracked, the poison is readily absorbed. Absorption by the intact skin is also possible if the mercury is vigorously rubbed in with a fatty substance as occurs in some cleaning operations. Penetration presumably occurs through the mouth of the pilo-sebaceous follicles and sweat glands. Mixed with sebum it passes along the ducts and reaches the sebaceous glands where it is absorbed through the gland cells According to the theory of Oppenheim when the skin does not let the mercury pass through there is dermatitis when the skin does allow passage there are no local inflammatory changes of the skin but mercurialism occurs.

Erythematous lesions can occur when mercury is absorbed It is therefore sometimes difficult to say how far an eruption is due to systemic poisoning and how far to external application.

Some individuals exhibit hypersensitivity to mercury Such a condition has been observed by the authors among several members of the same family The external application of a 1 per cent ointment of yellow oxide of mercury has caused marked swelling and erythema Several observers have also noted an increase in cutaneous sensitivity following injection or external application of mercury

Besides the skin lesions erosions of the mucous membranes and stigmata of the incisor teeth are noted among mercury workers (See Diseases of the Mouth.)

Mercuric iodide used in photography and medicine causes a general poisoning and dermatitis.

Mercuric cyanide used to make cyanogen gas and in photography may produce symptoms.

Mercury bichromate is very irritating to the skin It is used in chemical laboratories.

Mercurous chloride (calomel) is used sometimes in the decoration of porcelain in fireworks medicine and cosmetic creams. Pigmentation following its use has been seen by the authors and has been reported by others.

Mercuric chloride (corrosive sublimate) is a powerful germicidal agent which is used as a wood preservative by taxidermists in preparing skins of animals and by surgeons in dilute solutions as an antiseptic solution It is also used in the making of primary batteries, the pocket dry cell and in photography

Mercuric sulphide or cinnabar forms the so-called "vermilion" in which form it is manufactured for use as a pigment and for coloring sealing wax red.

Mercuric sulphate is used in the preparation of the two chlorides and in the extraction of gold and silver from roasted pyrites.

Mercuric sulphocyanate is poisonous and explosive It is used in photography and in preparing so-called Pharaoh's serpents

Mercuric oxide is used as a pigment and in making anti-fouling marine paints

Mercurous oxide is unstable and is converted into mercury and the higher oxide when exposed to light or gently heated.

Mercuric nitrate is used in gilding work, decoration of porcelain bronzing of steel embossing and in medicine Its chief importance however is due to its use in the carroting of rabbit fur in the preparation of felt hats. (See Chapter on the Manufacture of Felt Hats.) It gives rise to skin lesions similar to those caused by the bichloride Roberts describes the pharmacological action of mercuric nitrate as follows The nitric acid action is suppressed and the mercury ions preponderate He states that the effects of these ions on the skin are edema with leukocytic infiltration, and formation of a slough with rapid desiccation and separation of the crust.

Mercury fulminate is one of the chief offenders in the production of dermatitis during the manufacture of primers or detonating caps. (See Explosives.)

Ammoniated mercury is used in many cosmetic preparations such as freckle removers and skin bleaches Sensitivity to this compound is not uncommon, and a number of cases of dermatitis have been reported from contact with it. If iodine is used before ammoniated mercury is applied a violent dermatitis may occur Phenyl mercury nitrate phenyl mercury oleate, phenyl mercury lactate phenyl mercury acetate, phenyl mercury salicylate and ethyl mercury chloride are powerful insecticides and fungicides and also primary skin irritants The phenyl mercury compounds are used as antimildewproofing on fabrics and can cause dermatitis among those applying them to the fabrics, among those sewing the fabrics and among those wearing them. (See Fabric Finishes.) Ethyl mercury chloride is used as a wood preservative and has caused severe dermatitis among workers manufacturing it as well as among those applying it. (See Wood Preservatives.)

Nickel and Nickel Plating —Dermatitis is reported in many industries in which nickel and its salts are used Cases have also been reported among persons who come in contact with such nickel articles as spectacle frames, wrist watches and suspender buckles.

Nickel is found in its natural state in meteoric iron and also in ores combined with sulphur arsenic, magnesium and silicon Cobalt is present in almost all the nickel-bearing minerals.

There are various methods for the preparation of nickel but the most commonly used is the nickel-carbonyl process developed by Mond. This consists of (1) sorting the mineral by magnetic separators, (2) concentration, and (3) foundry work. The fused mass mixed with calcined coke is heated in a blast furnace. The *matte* of the nickel and copper sulphides is deposited at the bottom of large basins and there separates from the slag It is then passed to the Bessemer converters to eliminate the iron. The *matte* of nickel and copper sulphide is broken up ground and sent to the refinery

Calcination converts the sulphides into corresponding oxides. Copper is extracted after action by dilute sulphuric acid. The filtered solution passes to driers and the powder is subjected to reduction in steel towers. The mixture goes to volatilizers where a current of carbon monoxide combines with the nickel to yield nickel carbonyl This is decomposed with liberation of carbon monoxide which reënters the cycle and nickel is deposited on small pellets which fill the towers. The nickel thus obtained is 99.5 to 100 per cent pure and free from cobalt.

Much dust is produced in the process of refining the *matte* of nickel and although nickel oxide is but slightly irritating to the skin if at all "nickel refiner itch" is frequent among workers, particularly in a hot and humid atmosphere The lesions consist of papules situated at the mouths of the pores

In a refinery visited by the authors the process was as follows

The *matte* is received at the plant It consists of nickel about 74 per cent, copper about 2 per cent and sodium sulphide about 24 per cent. The *matte* is crushed and ground into course grains and dumped into leaching tanks where the sodium sulphide is removed with hot water the solution flowing out through the porous bottom of the tank. Weak sulphuric acid solution is added while the leaching is in progress.

The odor of hydrogen sulphide is strong over the leaching tank. Some dermatitis has occurred among the workers in this so called "wet room."

The acid solution in the tank is diluted with water until all acidity is removed The water is drained off and the remaining sand containing about 3 per cent of moisture is excavated It is while the excavating is going on that the worker is exposed to the nickel sulphide and copper sulphate and acid moisture Only an occasional new worker develops dermatitis and about every other one who does becomes "hardened" or immune after he recovers The contents of the leaching tanks are transferred to another room where it is dumped over the drying coils and the moisture removed until only 3 per cent remains. Some nickel sulphate is formed on the surface of the drying mass. A traveling belt removes the product to a pulverizer where it is again ground Some dermatitis has occurred among workers at the drying coils.

From the pulverizer the mass goes to the "sintering" plant where it is desulphurized by aeration and heating as it travels over a flame with a circulation of air through the mass.

The sulphur content is now reduced to about ¼ per cent The nickel is now converted into the oxide There have been no cases of dermatitis among the workers at this operation

The nickel oxide then goes to the melting department where it is reduced by means of heating with coke to an impure metal containing about 95 per cent nickel and the rest copper iron and some precious metals (platinum and iridium) This is then poured into a mold to form the anode for the Hybinette electrical deposition process.

In another process the nickel oxide is reduced to metallic nickel by heating with water gas which removes the oxygen In still another process nickel sulphide is roasted driving off the sulphur and forming the oxide This can be further reduced to nickel as described above

There have been no cases of dermatitis among workers in the melting department or at the water gas reduction process.

Hybinette Process —Most of the cases of dermatitis have occurred among workers at this process.

A large number of large electric cells containing a solution of nickel sulphate slightly acid (pH 4 to 5 roughly) has for the anode the impure nickel from the melting process. The cathode is obtained by electro-deposition of a thin sheet of nickel on a stainless

steel surface This "mother" plate of nickel is removed and made into the cathode by riveting to it suspending loops of nickel. In between the anode and cathode of the cell is interposed a frame of two pieces of canvas. This serves to permit the passage of the nickel ion only the copper iron and precious metals remaining on the anode in the form of a sludge. The spent anode is removed and the sludge washed off The sludge is dried and dumped into an electric furnace in combination with limestone, silica and slag, for the removal of the precious metals.

The workers over the electric cells are exposed to the solution of nickel sulphate and to the vapors containing some nickel sulphate which arises from the hot electrolyte solution The hands and arms of workers become wet with nickel sulphate and the face neck and body may be splashed with the solution or the steam may contain sufficient nickel sulphate to cause dermatitis in hypersensitive or sensitized workers. In the room where the solution of nickel sulphate is passed through the filter presses there is a similar hazard

Where the workers wash off the sludge from the spent anode there is also a hazard of dermatitis

Preventive Measures.—1 Since only new workers in the "wet room" and dry coil room seem to be affected it is advised that all new workers be supplied with clean coveralls and clean leather gloves daily and compelled to take supervised shower baths before going home The showers should be supplied with a toilet soap and the workers with individual towels.

2. New workers over the electric cells should be provided with long rubber gloves over which they should wear impervious sleeves either of rubber or vinylite, or pliofilm fastened over the gloves at the wrist to prevent the nickel sulphate from entering the glove Aprons of similar impervious material should also be provided A protective ointment consisting of animal or vegetable fats should be provided for new workers to use on the face and neck. This ointment is to be applied before work washed off before lunch reapplied after lunch, and finally washed off before going home

A suggested formula for the ointment

Anhydrous lanolin	70
Castor oil	30
Perfume	1

3. New workers at the filter presses should be provided with rubber gloves, impervious sleeves and aprons rubber shoes or boots as well as the protective cream advocated above

4 All workers, new and old washing anode scrap should be provided with long rubber gloves impervious sleeves and aprons, and rubber boots. The latter to reach to the hips. They should be compelled to take daily showers before leaving the plant.

Discussion.—Dermatitis from nickel sulphate is well known. It is a sensitization dermatitis, the worker becoming sensitized by industrial exposure. Statistics differ as to the percentage of new workers who became sensitized It is thought that the amount of

exposure is a factor in this. It is also known that a considerable percentage of those who become sensitized become "hardened" or desensitized after recovery from the dermatitis. It is advised therefore, that mild cases of dermatitis among new workers be continued at work while undergoing mild treatment and wearing protective clothing in the hope that they will get well while working and become "hardened." If such workers show no improvement after two weeks of work remove them from exposure until they recover. Then give them another trial at the job to see if they have become "hardened." If they again develop dermatitis remove them from the exposure.

Severe cases of dermatitis, who cannot work should be removed from the job until they recover and then given another chance at the job.

After a new worker has been in the plant for two months observing all the precautions advocated above for new workers and does not develop dermatitis or has recovered from dermatitis while working he can gradually accustom himself to do without the protective clothing and ointments. If he develops dermatitis as the clothing and ointments are discarded he must again wear them until such a time as "hardening" has occurred. Old workers who are "hardened" need not wear protective clothing and ointments, but showers after work are advised for all who have badly soiled clothes after a day's work.

Nickel is used in alloys with iron, chromium and tungsten for many purposes in metallurgy and with silver and gold in cheap jewelry and spectacle frames. It is also used to manufacture its salts which are important in nickel plating and for numerous other purposes.

Pure nickel is not generally thought to be a poison or an irritant. It has been taken internally in quantities of more than 100 mg. at one meal, nickel tableware being used without causing symptoms.

A number of cases of dermatitis have been reported due to contact with spectacle frames made of white gold, an alloy of gold, copper and nickel. The laboratory of the company making these frames after a careful study stated that the trouble was due to the nickel in the alloy. They believed but did not prove the action to be largely electrolytic due to dissimilar metals with the sweat acting as an electrolytic solution.

Lain reported lesions of the mouth caused by dissimilar metallic restorations and dentures, among them nickel, in which the saliva acting as an electrolyte produced electrogalvanic currents.

Howard Fox reported a case of dermatitis caused by a nickel watch strap which also produced a positive reaction when worn on the opposite wrist. Franck reported occupational eczema among watch makers including that due to nickel and its salts. Acne due to nickel sulphate was reported in a worker on baby carriages. Dubois described cases of eczema which resulted from wearing nickel-plated wrist watches and in each of these he was able to

demonstrate a cutaneous reaction to pieces of money which were almost pure nickel. Schittenhelm and Stockinger made tests which were positive only on areas previously affected. Others have obtained positive tests even on skin not previously involved.

Walthard sensitized guinea-pigs by painting the skin with nickel sulphate solution and produced dermatitis at the site. Jadassohn and Schaaf carried out similar tests on human beings, but could produce no skin irritation. They believed nickel did not cause eczema unless idiosyncrasy was present.

Nickel Plating.—Dermatitis among nickel platers is often observed but only a small percentage of cases are due to the nickel itself. (See Electroplating.)

Osmium.—A rare metal associated with platinum together with ruthenium, rhodium, palladium and iridium, which latter appear to be harmless. Osmium has a caustic effect on the skin. Eczema has occurred while separating osmium from mixtures of iridium and platinum, and osmium chloride has caused dermatitis when used in the manufacture of electric lamps. It has now been replaced by tungsten. Dermatitis has occurred among laboratory workers from splashes of osmium during attempts to regenerate reduced osmic acid with hydrogen peroxide. Subcutaneous injection of salts of osmium for therapeutic purposes had led to cutaneous necrosis. The substance is used in histological and chemical laboratories as a catalyzer, in the manufacture of platinum alloys for scientific apparatus, with iridium for tipping fountain pens, and for tipping tools used to engrave glass.

Phosphorus Manufacture.—Phosphorus is produced either from natural phosphates or from calcined bones by treatment with sulphuric acid which converts the neutral calcium phosphate into the acid phosphate. The solution is filtered and the concentrated filtrate is mixed with coke or sawdust and treated in muffle furnaces. Red heat is applied to earthenware retorts and the distilled product condensed in iron pipes. The phosphorus is further purified by distillation with steam or by filtration and is then run into molds under water.

Another method employs bone meal mixed with quartz sand and coke in an electrical furnace at 1300 to 1450° C. The vaporized phosphorus mixed with carbon monoxide passes into a condenser where it condenses immediately and it is then run under water. Calcium silicate remains as a residue in the furnace. The same process is also applied to natural phosphates.

The resulting substance is colorless or "white" but turns yellow under the action of sunlight. Since phosphorus ignites spontaneously on contact with air it is marketed covered by water containing small amounts of alcohol or glycerine to prevent freezing. The water-tight metal containers are placed in wooden boxes or barrels which are painted with tar and wrapped in straw or canvas.

The operation of crushing the bones is a source of danger if the dust is not adequately removed and fumes of phosphoretted hydro-

gen and carbon monoxide are given off during treatment of the bones There is always the possibility of phosphorus poisoning in this work but due to the precautions taken the cases are fewer than might be expected Skin hazards are presented by the excessive heat of the electric furnace by irritating acids and fumes and by the manipulation of tar in painting the barrels. Packers who handle straw may develop an itching dermatitis from acari

At the present time white phosphorus has limited uses It enters into the composition of phosphor bronze, certain synthetic colors rat poisons artificial manure liquid and incendiary projectiles fireworks, smoke screens and the paraffined strips of paste used for relighting miners lamps.

Phosphorus is sometimes present as an impurity in other substances. For example ferrosilicon used in the manufacture of steel is an alloy of iron and silicon and contains both arsenic and phosphorus When subjected to moisture ferrosilicon containing a certain percentage of silicon decomposes and gives off arseniuretted and phosphoretted hydrogen Fatal poisoning from this source is possible and has occurred under exceptional circumstances. Phosphorus may also occur as an impurity in acetylene gas and constitute a danger to users

The chemically pure substance is not considered highly toxic until oxidation takes place. The slow combustion that occurs on exposure to moist air produces noxious fumes that enter the body through the respiratory tract Food contaminated by particles or fumes of phosphorus carries the poison to the digestive organs. Decayed teeth or slight lesions of the mouth afford easy entry and the mouth and jaws are usually the parts most seriously affected

Although absorption of phosphorus through the skin appears to be very rare local injury occurs in the form of painful burns that are slow to heal Such burns arise from two destructive processes (1) direct injury from the flame and (2) corrosion of the tissues by the acid that is formed It is important to put the injured part as promptly as possible into a 5 per cent solution of sodium bicarbonate at body temperature lifting it out from time to time so that the air can reach the burn and facilitate oxidation of the particles of phosphorus still adhering to the tissues The alkaline solution reduces the pain by neutralizing the newly forming acid. The alternate exposure to the air and to the bicarbonate bath should continue until there is no further development of phosphorus pentoxide vapor and the garlicky odor phosphorescence and extreme pain have ceased Thenceforth the usual treatment for burns suffices.

Among workmen engaged in preparing rat poison dermatitis has occurred on the hand fingers and feet accompanied by irritation of the tongue throat nasal mucosa, and conjunctivae

So many cases of phosphorus poisoning occurred in the match industry from 1831 to 1808 when white phosphorus was generally used for match heads that preventive measures became imperative

As a means to this end red phosphorus was gradually substituted for the white

Red phosphorus is an allotropic form obtained by heating white phosphorus to 250 to 300° C. in air tight vessels, or at a lower temperature with the addition of a little iodine. After cooling it is purified with carbon bisulphide or sodium hydroxide.

Some authorities claim that red phosphorus is innocuous and that the cases of poisoning which still occur from it are due to traces of white phosphorus that have not undergone transformation Others contend that the modified substance is toxic but to a lesser degree than the white The fact is that the bone necrosis does occur from the use of red phosphorus, although few cases are reported.

At the present time red phosphorus is used chiefly in the manufacture of friction strips for safety matches and an even less noxious compound phosphorus sesquisulphide is employed for the heads of strike anywhere matches. The sesquisulphide is prepared from red phosphorus. It decomposes slowly in the air and does not give off noxious fumes.

Phosphorus is used in the manufacture of incendiary bombs. When phosphorus touches the skin it produces severe burns which heal very slowly When phosphorus falls on the skin a 5 to 10 per cent solution of copper sulphate should be applied as soon as possible to neutralize the phosphorus. Goldblatt and Oakeshott compared the inactivating properties of copper sulphate, copper sulphate-glycerol-starch mixture copper oleate-sulphonated castor oil mixture and trichlorethylene-ethyl alcohol mixture and found that the last was the best.

In 1920 Nicolas Gaté and Rousset reported 2 cases of dermatitis among workers engaged in weighing and filling bottles with phosphorus sesquisulphide. Within a day or two after exposure a brilliant red rash appeared on the hands and forearms of 1 patient and spread all over his body in the course of twenty four hours there were a few scattered bullæ The rash was accompanied by severe itching and followed by extensive desquamation Recovery took place twelve days after the patient stopped work. In the second case the outbreak was more acute. On the first day of exposure the patient suffered inflammation of the eyes, with photophobia. This caused him to give up work for two days during which time the condition cleared up. Upon returning however the ophthalmia reappeared and within forty-eight hours the patient's entire body was covered by an erythematous vesiculo-pustular eruption. The lesions were most severe on the flexures of the limbs and body and on the penis and scrotum some of the bullæ being quite large The patient felt very ill and complained of thirst In both cases there was a strong and persistent odor of phosphorus and phosphoric acid was found in the bullæ and scales.

Cases of dermatitis have also been reported by Swars (1925) due to *phosphorus sesquichloride* on the friction strips of match boxes.

Platinum.—Contact with the oxide has been reported to cause eczematous lesions and the authors have observed the development of sensitivity to platinum chloride in a chemist who suffered a generalized eruption from contact with a small amount of the substance The trioxide has also given rise to dermatitis. (See Jewelry and Allied Industries) Photographers have been reported to contact dermatoses from platinum solutions used in their work. (See Chapter on Photographing)

This precious metal is used not only for jewelry but also in the manufacture of scientific instruments as well as a laboratory reagent Asthmatic symptoms are not uncommon among workers exposed to the salts of platinum Hunter *et al.* state that 52 out of 91 men exposed to the dust or spray of platinum salts had asthmatic symptoms and 13 had dermatitis

Potassium has an irritating effect on the skin similar to that of sodium (See Chapter on Alkalis.)

Radium.—Radium and other radio-active substances cause burns and dermatitis. (See Chapter on Dermatoses Caused by Physical and Mechanical Agents—Radio-dermatitis.)

Selenium.—Selenium is an element somewhat similar to tellurium (*q v*) Most of its compounds are said to be transformed in the body into dimethyl selenium which causes a garlic-like odor of the breath and perspiration but does not like tellurium arrest the flow of perspiration

Seleniuretted hydrogen is a highly toxic gas with an odor of decaying radishes It irritates the mucous membranes and the skin causing folliculitis boils and dermatitis as well as producing constitutional symptoms similar to those of arsenic poisoning

Motley Ellis, and Ellis report several cases of sore throat occurring in laboratory workers at the University of Missouri Medical School due to contact with dogs who had been injected with selenium. The condition was more painful and prolonged than the usual pharyngitis due to infection there were excessive secretions in the posterior pharynx, which caused constant expectoration and coughing The room was poorly ventilated and the exhalation of methyl selenide or selenium in other organic combinations from the dogs produced a garlic-like odor in the air The dogs themselves developed severe pulmonary edema. Another case of sore throat occurred in one of the authors within two and a half hours after weighing some sodium selenite In all these cases the possibility of common colds were ruled out

Mild toxic effects have also been noted among animals and human beings living on seleniferous soil in wheat-growing states of the U S due to ingestion of wheat and other plants containing the poison Smith Franke and Westfall studied 111 families on farms in Wyoming South Dakota and Nebraska a large proportion of whom exhibited the following symptoms discolored and carious teeth, icterus various kinds of skin eruptions arthritis transverse and longitudinal ridging of the nails and occasional sloughing sub-

cutaneous edema peripheral neuritis and gastro-intestinal disturbances In more than 92 per cent of the patients selenium was present in the urine

Bronchial irritation sore throat, fever and digestive troubles have also been noted in a copper foundry among workmen engaged in crushing selenium-bearing ores and in the melting process due to the dust and fumes of selenium

According to Hanslik and Tarr selenium bromide is a cutaneous irritant to dogs and man. Dermatitis has been reported in a chemist due to potassium selenite and selenic acid anhydride. Patch tests were positive with these and negative with pure selenium The dermatitis recurred when the patient resumed work after a long interval

Crystalline selenium is used in the construction of photo-electric cells, telephonic apparatus with luminous rays in telephotographic apparatus, in alarm apparatus (the electric eye) and in photometry Dermatitis from selenium has been reported in these industries. In the glass and pottery industries vitreous selenium and sodium selenite are used to impart a rose color and selenite for taking the greenish shade out of glass.

Selenous acid H_2SeO_3 colors the skin brown by precipitating metallic selenium on the skin and on long contact produces dermatitis.

Selenic acid H_2SeO_4 is corrosive and especially attacks the nails.

Selenium dioxide is used as a coating material and produces vesicular dermatitis.

Selenium oxychloride $SeOCl_2$ is a vesicant causing slow healing burns.

Silver.—Silver may produce argyria among silversmiths and others who handle the metal (See Jewelry and Allied Industries.)

Sodium.—Many of the compounds of sodium give rise to dermatitis (See Alkalis.)

Strontium.—The hydroxide is a caustic irritant.

Tellurium.—Salts of tellurium are believed to be absorbed through the skin as well as through the respiratory and digestive systems. The substance inhibits the dermal secretions and causes dryness of the skin and mucous membranes of the nose and mouth Other symptoms of tellurium intoxication are somnolence and a garlic-like odor of the breath and sometimes of the sweat Its physiological action is similar to that of arsenic although the breath odor is much more pronounced. In the body tellurides are changed to metallic tellurium which gives the odor to the secretions and excretions.

Shee and Deeds found that moderate exposure to the fumes and dust of tellurium for a few weeks or months caused a metallic taste in the mouth, inhibition of sweat and a scaliness and itching of the skin

The substance exists as an impurity in minerals such as lead copper gold silver selenium and iron.

In one department of an electrolytic lead refinery all the workers

were reported (in 1918) to have developed a garlic breath and many of them exhibited a dry skin with arrested perspiration These men had all been in contact with tellurium in the silver refinery working at furnaces heated to over 700° C and were exposed to the dust and fumes of tellurium probably as hydrogen telluride in the fumes and oxide and telluride in the furnace dust.

Tellurium has but few industrial uses at the present time It is employed in the glass industry to impart a blue red or brown color to the glass. It has been tried as a substitute for coke in the iron and steel industry and in laboratory work to reveal the presence of bacterial life Compounds of tellurium have also been used experimentally in the treatment of syphilis.

According to the United States Department of Labor copper and lead refiners and workers who color glass are the ones most exposed to hazards from tellurium.

Thorium.—A radioactive substance. The nitrate has caused dermatitis in a worker engaged in making gas mantles. (See Incandescent Lamp Manufacture.)

Tin.—Although this metal is not considered an irritant a skin eruption spoken of by tinsmiths as tin itch has been observed by Fischl in a capsule factory in Breslau He is uncertain however whether to attribute it to the tin, lead or cleaning oil. Dermatitis is reported to have occurred among dyers and tinsmiths from contact with tin chloride and among silk workers from the tetra chloride used in weighing silk. Paschkis, in 1912 stated that contact with bichlorides and perchlorides of tin solutions cause ulcerations similar to those produced by carbonic acid snow Tin picklers have a hard bleached (and sometimes atrophic) skin with numerous cracks and excoriations from contact with the sulphuric or hydrochloric acid and often suffer from chronic gingivitis with blackening and breaking off of the teeth.

Titanium.—The tetrachloride is said to be a cutaneous irritant The oxide of this metal is a white solid used as a mordant in dyeing as a pigment in the rubber industry and in the manufacture of synthetic resins and oil cloth. It is also used in preparations of face powders and beauty creams It is said to be devoid of toxicity

Tungsten.—Tungsten is a gray metal which exists in combination with other ores the most important of which is wolframite It is used for the manufacture of tungsten steel and as filaments in the incandescent lamp industry

Although experimental animals have been shown to be slowly poisoned by tungsten salts no cases of occupational systemic poisoning or dermatitis have been reported as caused by it

Vanadium.—Vanadium is found in nature in the ores of other metals. The principal ore from which it is derived is vanadinite where it is combined with lead. The principal use of vanadium is in the preparation of special steel alloys. It is also used in dyeing and printing of cotton and in the manufacture of glass porcelain and blue ink.

Vanadium compounds may prove toxic on ingestion. In experimental poisoning E P Daniel (Experimental Vanadium Poisoning in The White Rat, Public Health Reports 53 765–777 May 13 1938) there is inflammation of the mucous membranes of the eyes nose and gastro-intestinal tract accompanied by nervous symptoms Cases of industrial vanadium poisoning have not been reported in the United States.

Zinc.—Zinc is found abundantly in Nature as blende which is zinc sulphide as calamine, a zinc carbonate as hydrated silicate of zinc or Smithsonite and in several other ores.

It is extracted from the ores by roasting in ovens or by electrolytic processes. It is a grayish-white metal used for soldering coating telegraph wires, roofing galvanizing and plating making alloys (principally brass) making lithographic plates and for vat dyeing Powdered metallic zinc is a reducing agent, decomposing water with an emission of heat and liberating hydrogen.

Dermatitis is not a problem in zinc foundries. Zinc chills or brass founder s ague does occasionally occur

Zinc chloride ($ZnCl_2$) is probably the most irritating of the zinc salts. It is freely soluble in water and since soluble salts of zinc precipitate albumin in the tissues it has a caustic action in strong solutions and an astringent action in dilute solutions. Zinc chloride is also hydroscopic and will extract water from organic tissues to such an extent as to carbonize them It is in this manner that powdered zinc chloride causes ulcers of the skin and of the nasal septum.

Zinc chloride can be made on a large scale in concentrated solution by heating a zinc salt with ferrous chloride and passing a current of air through the liquid In a factory inspected by the authors zinc chloride is made from a dark gray sludge which is a by-product of galvanizing plants. The sludge contains metallic zinc and zinc salts, and the workers engaged in shoveling it often develop dermatitis of the hands and arms and even of the covered parts of the body if the working clothes are allowed to become saturated with the substance In this factory sludge is automatically washed and slurried the metallic zinc thus being recovered The remainder of the liquid is treated with hydrochloric acid resulting in a solution of zinc chloride. The zinc chloride solution is concentrated along a cascading series of boiling receptacles the last one containing a highly concentrated solution. This is evaporated to dryness and the crystals are ground into a powder The series of boiling receptacles is covered with a long suction exhaust hood to draw gases and fumes away from the workers. The drying and grinding is done in a totally enclosed apparatus and the barrels are filled directly from the grinders. A cover is placed over each barrel while it is being filled to prevent the dissemination of dust and the barrel is placed over an automatic shaker to settle the contents and allow the complete filling of the barrel. Before the installation of these safety measures dermatitis and nasal mucitis had occurred

frequently among the workers. While the incidence of these conditions has diminished since the installation of these safety precautions the man who supervises the filling of the barrels lifts the cover occasionally to see if the barrel is filled and in so doing is exposed to some dust. This has resulted in a perforation of the nasal septum

In another chemical factory where zinc chloride was one of many products manufactured there occurred 152 cases of dermatitis from all causes during the period of thirteen months. Of this number 49 or more than one-third were due to zinc chloride.

The classified causes of these cases were as follows

Acids	19
Sodium hydrate	6
Sodium metasilicate	2
Soda ash	11
Trisodium phosphate	3
Lime	2
Globular sodium bisulphate	7
Sodium sulphate	1
Butylamine	1
Heat	16
Thermal burns	29
Zinc chloride	49
Unclassified	6
Total	152

In addition to the above there were 6 cases of burns of the eyes from zinc chloride out of 16 cases of eye burns from all causes.

No record was kept of small ulcers due to zinc chloride nor were there any examinations made to discover ulcerations of the nasal septum. During the course of the inspection made by the authors a causal examination of one worker engaged in shoveling the dry powdered zinc chloride revealed a large perforating ulcer of the nasal septum

Ulcers caused by zinc chloride (Fig 17) are deep and burrowing with but little inflammatory reaction around the edges They are covered by a tenacious gray slough and will not heal until this slough is removed. The ulcers may be tender and painful but at times they are insensitive. The most efficacious treatment is to remove the adherent slough curette and cleanse the base of the ulcer apply powdered bicarbonate of soda to the wound and dress it aseptically

Zinc chloride is used in soldering The solderer dips the iron into the hydrochloric acid and applies it to the metallic zinc. Zinc chloride is formed and is given off in fumes which may cause dermatitis and ulceration. Zinc chloride is also used as a wood preservative and McCord and Kilker have reported dermatitis from it among workers using it to impregnate wood

Ulcerations of the buccal gastric and duodenal mucous membranes among zinc workers attributed to zinc chloride have been reported by McCord and Friedlander

Workers who handle zinc chloride should wear rubber gloves and should change daily to fresh work clothes. Those exposed to the dust or fumes should wear respirators and apply an ointment of vaseline to the anterior nasal mucous membranes. Dusty processes or those giving off fumes should be either totally enclosed or well vented with local suction hoods.

FIG. 17.—Zinc chloride ulcers in chemical worker. The basis of the ulcer must be curetted before they heal. Zinc chloride dust causes ulceration of nasal septum.

Lithopone.—Lithopone is a mixture of zinc sulphide and barium sulphate. It is used in paints instead of white lead because it is not poisonous. Lithopone is made by first mixing zinc ore with sulphuric acid forming a solution of impure zinc sulphate. Dermatitis and acid burns may result from splashes at this operation. The impurities, consisting of iron, manganese, nickel, cadmium and copper are removed, leaving a pure zinc sulphate liquor.

Barium sulphate, or barytes, is mixed with fine crushed coal and placed in a rotary calciner in which it is heated and converted into a black impure barium sulphide called "black ash." This is dumped into large tanks of hot water which leaches out the barium sulphide, leaving a dark inert mud. The men working on the calciner and on the leaching tanks sometimes develop dermatitis and burns from the barium sulphide in the form of powder or solution. Dermatitis may develop on the exposed parts or on the covered parts, if the dust of "black ash" or the solution of barium sulphide penetrates the clothing.

The barium sulphide liquor is mixed with the zinc sulphate liquor in large wooden tanks, resulting in the precipitation of zinc sulphide and barium sulphate. The milky liquor is passed through continuous drum filters, some magnesium hydroxide is added, and the precipitate is passed through a dryer, after which the lithopone is

taken to storage bins. Here ammonium chloride is added to the lithopone and it is again passed through a calciner heated and then poured into water while red hot It is again dried and then finely ground In the drying grinding and conveying of the powder there is considerable dust created and dermatitis may result from dust irritation of workers exposed

Zinc Sulphate—Pure zinc sulphate can be made by dissolving zinc in sulphuric acid or by roasting zinc sulphide and then treating with hot dilute sulphuric acid. It is used for the preservation of wood and hides, for fireproofing fabrics, as a mordant in textile printing and in medicine.

Zinc sulphate has a similar but milder action on the skin than zinc chloride Kumnin describes a dermatitis among Russian zinc platers which he calls "Vogel auge" (bird s eye) the principal cause of which he states is zinc sulphate

Zinc Oxide—Zinc oxide is obtained by burning zinc in air This can be done by burning powdered zinc or by burning zinc scrap in specially designed furnaces. It can also be obtained directly by roasting various zinc ores.

Workers with zinc oxide powder occasionally suffer with an eruption called zinc pox. This occurs usually on most covered regions such as the groin and axilla and consists of white centered acne-like papules caused by the dust mechanically blocking the openings of the follicles. Secondary infection of the follicles may cause pustules to form. Zinc chills also occur among workers exposed to the dust of zinc oxide Zinc oxide is used in paints as a substitute for white lead and also in medicine

Zinc peroxide is a good deodorant and antiseptic It is used in deodorant powders and in the treatment of wounds.

Zinc chromate is a yellow pigment used in filler paints on metal especially on duralumin and Dow metal Dermatitis often occurs among workers applying the paint either by brush or spray gun. It is usually attributed to the pigment but in most cases it is actually caused by paint thinner

Chrome yellow is a double salt of zinc chromate and potassium dichromate and it is probably the potassium dichromate radicle which causes dermatitis. It is possible however that even pure zinc chromate can cause dermatitis in a person allergic to chromates.

ALLOYS AND AMALGAMS

Various metals are fused by heat with other metals to increase their hardness and tenacity The result is an alloy Mercury combines with many metals without being heated to form combinations known as amalgams.

Alloys.—The process of fusing metals is usually effected under a flux or some material that facilitates liquefaction and prevents contact with air For example in the melting together of lead and tin for solder a mixture of rosin and tallow with a small amount

of sal ammoniac is melted and applied to the metals to prevent oxidation. Charcoal is applied to zinc and copper for the same purpose.

Brass.—Brass is generally composed of two-thirds copper and one-third zinc, although some lead or tin is often included This produces a fine reddish brass. From this standard the proportions are subject to many variations a greater amount of zinc and less copper for example, producing an inferior yellow brass.

In common foundry practice, miscellaneous scrap metals make up a third or more of the alloy Thus while the brass manufacturing industry utilizes large amounts of copper zinc, and tin, other metals or non-metals such as lead antimony nickel aluminum cadmium manganese iron phosphorus arsenic and sulphur may enter into the composition of brass The toxins volatilized from the various metals by heat give rise to brass founder's ague. In brass foundries the condition is produced chiefly by fumes of zinc oxide and is similar to fume fevers resulting from other metals such as copper nickel, iron, antimony cobalt cadmium etc. Dermatitis may occur among brass founders from arsenic phosphorus antimony sulphur dioxide carbon dioxide and also from the intense heat of the furnaces. At the end of the melting operation when almost pure zinc is poured into the crucible zinc oxide is liberated in tiny flakes that fill the air like snow (See Zinc.)

Brass castings are finished by sandblasting or by steel wire brushes operated by hand or by machinery Polishing is done with emery wheels and the brass is then buffed on wheels covered with leather or cloth These operations create large quantities of irritating dust The dark, coarse "crocus rouge used to polish brass is often responsible for eruptions of the skin.

The term "brass poisoning" has come into common misuse among workers handling brass. They often attribute all skin irritations to the brass and call it "brass poisoning" Patch tests with brass performed on such patients by the author have all been negative Brass dust and slivers may cause dermatitis by mechanical irritation but is no more irritating to the skin than steel.

Acid fumes which arise from the pickling vats containing hot solutions of cyanides or a mixture of concentrated sulphuric and nitric acids may irritate the skin and dermatitis may occur from this source or from dipping the hands and arms into the solutions. Intractable ulcers result from contact with the cyanide solutions, and also among polishers from the use of potassium cyanide

Art brass after being cleaned and polished is generally lacquered to prevent tarnishing In this operation the lacquers and solvents such as carbon disulphide amyl acetate benzene and wood alcohol are frequent causes of dermatitis

Bronze.—Copper and tin are the chief components of this alloy although other metals such as aluminum zinc lead antimony and phosphorus are often present in various bronzes. After fusing the metal is brittle and the castings are plunged while red hot into cold

water and subjected to hammering reheating and cooling (annealing) after which they become soft and ductile.

Art bronze for statues which contains high percentages of lead and zinc is soft. Japanese and Chinese bronze which are very rich in lead are used to make coins, medals piping etc. Bismuth bronze consists of copper zinc lead and bismuth, and sometimes antimony It is used to make mirrors rollers for printing cotton goods lamp reflectors and for cementing glass Aluminum bronze containing a large proportion of aluminum with lead zinc, brass or other metals is a hard alloy much used for cheap jewelry table and kitchen ware

Phosphor bronze contains copper tin lead and a fractional proportion of phosphorus. Sticks of phosphorus are coated with copper to keep them from igniting in the air and kept in a jar of dilute copper sulphate They are taken out dried and added to the other (heated) metals, whereupon the phosphorus immediately begins to melt and volatilize *Although this is an extremely hazardous operation* phosphorus poisoning is rare among the workmen Phosphor bronze possesses exceptional strength and tenacity and is very resistant to sea water On account of the very beautiful patina produced by exposure to air the metal is much used for art purposes.

Potassium cyanide used for cleaning bronze has caused ulceration of the skin and burns due to dilute sulphuric acid are said to be common in bronzeware factories.

The greatest cutaneous hazards connected with this alloy however appear to be in the manufacture and use of liquids and powders for bronzing and coloring other articles.

Bronze powders consist of varying proportions of pulverized metals or non-metals according to the shade desired Arsenic and antimony sulphide for example produce a rose color Different shades are also obtained by heating the powder with oil wax or paraffine The powder is mixed with a solution of gum and water with a special varnish having a gum-lac basis or with resins Brown shades are obtained by exposure to fumes of sulphuretted hydrogen or ammonium sulphide.

Silver bronze is a mixture of bismuth tin and mercury fused in a crucible Gold-bronze consists of tin oxide and sulphur heated together in a retort The alloys are then pulverized and mixed with gum or varnish in the usual way

Bronze powder is used in printing and lithographing to color wall paper and mural decorations to bronze metal leaf and such articles as trays, lamps, tin boxes, and bicycles to stamp various articles with a name or trademark and to coat paper wood leather glass, textiles etc

Imitation gold leaf used to gild molding picture and mirror frames furniture etc consists of bronze powder (French flake) in a varnish of celluloid acetone and amyl acetate

For liquid bronze acid-free varnish is used To remove the acid from dammar resin petroleum benzine is poured over the

finely powdered resin and a 10 per cent aqueous solution of sodium hydroxide is added. Or the resin may be heated with calcined soda and when it is cool benzine is added and the solution is filtered. Bronze powder is then mixed with the filtrate.

Metallic articles to be bronzed are first cleaned with potassium permanganate, potassium cyanide, benzine, hydrochloric acid, ammonium sulphide, etc. Brass and steel are soaked in hydrochloric acid containing dissolved arsenic.

Many sources of dermatitis exist in the manufacture and use of bronze and bronzing mixtures. A fine dust containing mercury, arsenic, antimony, etc., arises during the processes of pulverization and polishing and cannot all be drawn off by the best of modern apparatus. Stomatitis, gingivitis, and a greenish discoloration of the teeth, hair, and perspiration have been reported among workers exposed to the dust. Dermatitis and constitutional symptoms due to bronzing powders occur among lithographers.

The substances and solvents that may give rise to dermatitis among bronze workers, and especially bronzers, are as follows:

Acetone	Lacquers
Ammonium sulphide	Lead
Amyl acetate	Mercury
Antimony sulphide	Methyl alcohol
Arsenic	Phosphorus
Arseniuretted hydrogen	Sulphur dioxide
Benzine	Sulphuretted hydrogen
Sodium hydroxide	Resins
Celluloid (pyroxylin)	Turpentine
Benzol	Varnishes
Hydrochloric acid	

Nickel Alloys.—Nickel is fused with smaller proportions of copper and other metals for numerous purposes. An alloy for watch springs is composed of nickel (60 per cent) with iron, chromium, and small amounts of manganese, molybdenum, and beryllium. Combinations of nickel, copper, and cadmium with tungsten or platinum are also extensively used in watchmaking. Nickel and its salts have been incriminated as the cause of numerous cases of dermatitis, many among watchmakers. (See Chapter on Nickel and Nickel Plating.)

Manipulation of chromium is a source of ulcers and dermatitis. (See Chromic Acid and the Chromates.) Hydrofluoric acid fumes evolved in the melting of beryl may also produce skin eruptions.

A nickel alloy for making magnetic cores consists of nickel, 60 to 80 per cent, and cobalt, 20 to 40 per cent. Cobalt as well as nickel may produce dermatitis.

Britannia Metal.—Britannia metal contains about 90 per cent of tin and 10 per cent of antimony. Small proportions of copper, zinc, and lead are sometimes included. Antimony is the chief skin hazard in this alloy.

Gold Alloys.—Gold is generally alloyed with silver and copper and involves risk chiefly from heat and the cleaning materials used such as sodium hydroxide and nitric acid

Silver Alloys.—Silver alloys consist of silver copper and nickel or cadmium or of silver and aluminum Argyria has occurred from contact with silver (For risks connected with the treatment of gold and silver see Chapter on Jewelry and Allied Industries)

German Silver is an alloy of copper zinc and nickel

Pewter—Pewter may consist of tin and lead only or of tin with antimony and copper A pewter consisting of tin antimony, and lead is extensively used for making small toys and other articles for general use Lead or antimony poisoning and dermatitis may occur among the makers of pewter

Lead and Antimony are the ingredients of engraving plates.

Amalgams.—Dermatitis has been reported due to the handling of mercury amalgams. The potassium and sodium amalgams decompose in water with evolution of hydrogen and are frequently used as reducing agents Amalgams composed of 25 per cent zinc 25 per cent tin and 50 per cent mercury as well as amalgams of cadmium and cadmium tin are used as dental cements and the first-named is used also in the construction of electrical machines

Amalgams of gold and copper are used by dentists as fillings for teeth and tin amalgam is employed for silvering mirrors. Of this group silver tin (Ag_3Sn) is stated to take up the maximum amount of mercury

There is also a native amalgam of mercury and silver in which the proportion of silver ranges from 27.5 to 95.8 per cent and a native gold amalgam containing from 39 to 42 6 per cent is found in California and Colorado

In amalgams of mercury with aluminum antimony gold and some other metals which require the action of heat to cause union part of the mercury becomes volatilized and the fumes as well as the substance itself or its solution may give rise to mercury dermatitis (See Mercury and Its Compounds.)

The other irritant metals with which mercury is combined antimony strontium etc. and hydrochloric and sulphuric acids used in the treatment and application of amalgams are also sources of cutaneous hazard.

Following is a list of other common alloys

Alclad—An alloy of aluminum copper magnesium manganese and iron *It is used in airplane manufacture*

Babbit s Metal—An alloy of tin copper and antimony It is used as a bearing surface.

Carboloy—An alloy of cobalt tantalum tungsten aluminum and carbon used as cutting tool

Dow Metal.—An alloy of magnesium manganese silica and aluminum used in airplane manufacture

Dural.—An alloy of aluminum copper magnesium, manganese and iron.

Kirksite.—An alloy of zinc magnesium and aluminum used in airplane manufacture

Monel Metal.—An alloy of copper and nickel

Occupational dermatitis is rare from these alloys. Those containing nickel and antimony may cause an occasional case of dermatitis among those wearing jewelry made of them The term "Dural poisoning" has become common among airplane workers but while it is true that there may be a few isolated cases of allergy to the alloys used in airplane manufacture by far the majority of so-called "dural poisoning" is due to some other materials, such as petroleum oils resins, solvents and pigments. F Marquardt rubbed dural filings on human skin for fourteen days and introduced into the same site slivers of dural but failed to produce sensitization. The authors have performed hundreds of patch tests with dural without a single reaction

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CHAPTER XIV

DERMATOSES CAUSED BY CHROMIC ACID AND THE CHROMATES

CHROMIC acid and the chromates are powerful skin irritants and corrosives. They are extensively used in many manufacturing processes.

Chromic acid itself or chromium trioxide is made by boiling sodium bichromate with oleum. It is liquid while hot and is allowed to solidify in shallow pans. Fumes rise from these pans and permeate the air of the room unless they are removed by ventilating hoods.

In a factory manufacturing chromic acid the men working at this operation wore respirators and gloves but in spite of these precautions there were 8 cases of perforation of the nasal septum among 20 workers. The lesion began as an ulceration about one month after working over the pans. Nosebleeds were first noticed and these occurred from time to time. In a year or so the perforation of the cartilaginous septum was complete.

Ulceration of the nasal septum and of the skin is of frequent occurrence in the manufacture of chromates. (Fig. 18.) The chief offenders are the alkaline chromates, potassium bichromate and sodium bichromate.

Chromium is found in Nature as chrome iron ore. It can be obtained pure by heating chromic oxide (Cr_2O_3) with aluminum powder. The chrome iron is heated with lime and soda to form sodium chromate (Na_2CrO_4). The batch withdrawn from the oven is cooled by pouring water on it and steam evolved from the slaking of the lime carries particles of chromate into the air of the room. When the batch is cooled it is broken up and more dust is disseminated. Hot water is then run onto the broken mass in order to dissolve the chrome salts, and steam coming from this bath also contains chromium compounds which permeate the workroom.

The workers at these operations suffer from chrome ulcers and dermatitis. In a factory examined by the authors where chromates are manufactured directly from chrome ore, nearly all the workers had ulcerations or perforations of the septum and numerous scars of chrome ulcers on the hands and arms. The slightest abrasions of the skin may become "chrome holes."

The International Labor Bureau states that in Germany in a certain chrome factory employing 700 men there were 71.42 cases of perforation of the nasal septum per 100 workers over a period of seven years. During this same period there were 20.71 cases of dermatitis per 100 workers.

In 1912, in Prussia, it was noted that 90 per cent of all of the workers in chromate works were affected, but medical examination

and careful selection of the candidates led to a reduction of the incidence of these conditions to 5 per cent In 1922 an investigation made at a chromate factory in Germany dealing with a period of sixteen years and 210 workmen perforations of the nasal septum were found in 28 workers marked ulceration in 117 workers, and only slight ulceration in 17 workers. Only 48 of the workers had no lesions in the nose

In Great Britain Legge reported in 1902 that out of 176 workmen 71 6 per cent had perforation of the nasal septum and 11 3 per cent had ulceration of the nasal mucous membrane without perforation.

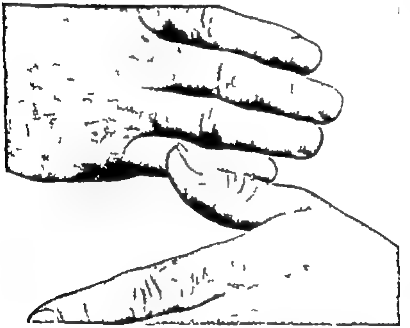

FIG. 18.—Chrome ulcers of hands of leather tanner

In Russia Wilensky in 1924 found 107 out of 278 workers in a chromate factory affected with lesions 49 had ulcers of the nasal septum 92 had perforations, and 116 had pharyngitis due to chrome

Chrome causes lesions of the skin and mucous membranes. According to the resistance of the individual it produces dermatitis of varying severity (Fig 19) Acute dermatitis from chromium will often occur when the workers are exposed to the steam from boiling bichromate solutions Constitutional symptoms with pain and swelling may accompany the acute dermatitis. Chromium may also cause systemic poisoning if absorbed through the skin. R. Prosser White quotes Hansen who reported 12 deaths following the external application of an antiscabetic ointment which contained chrome instead of sulphur

Goldman and Karotkin report poisoning from taking chrome internally.

McCord *et al.* applied dressings saturated with solutions of potassium and ammonium bichromate and chromic acid and concluded that these substances readily produce skin irritation of normal intact skin.

Ulcers usually develop when chrome is deposited on an abrasion. They usually appear without pain and are round, hard, and covered by a tenacious crust. The edges of the ulcer are thick and rounded and may be only very mildly inflamed. The center is deep. The lesions persist indefinitely and may grow in size unless treated; on healing they leave scars. The ulcers in the nose are usually situated

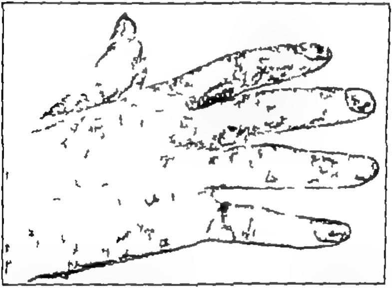

FIG. 19.—Occupational dermatitis in a chemist due to chromium. Patch test positive to potassium bichromate. (Case of Dr. A. Rose Smith, College of Physicians and Surgeons, Columbia University, New York.)

on the cartilaginous portions of the septum and are often present without awareness of them. Ulcerations of the tonsils, palate, eyelids, conjunctiva, and cornea have been noted.

Among 1,000 cases of industrial dermatitis reported by the state of Ohio there occurred 60 cases of chrome ulcer and 31 cases of chrome dermatitis, or about 9 per cent of all the cases of industrial dermatitis. Of the chrome ulcers, 36 were in the nose and 24 on the other portions of the body. The electroplating industry accounted for 49 of the cases of chrome ulceration and dermatitis and chrome manufacturing plants accounted for 25 cases. The developers of blue-prints accounted for 9 cases of dermatitis, no ulcers occurring among this type of worker. A blue-print developer is exposed to a dilute solution of potassium bichromate. There

were 2 cases among photoengravers due to solutions of ammonium bichromate and 4 in miscellaneous industries.

Englehardt and Mayer found 26 workers with eczema among 114 workers exposed to chromates in the photographic and lithographic trades and among 30 workers employed in the manufacture of chromates they found 20 cases of perforation of the nasal septum. They performed patch tests with a 0.5 per cent solution of bichromate on workers engaged in these trades, who had had an eczema at one time or another and found that 74 per cent of them gave positive reactions whereas patch tests performed on exposed workers who had never developed dermatitis gave only 8.5 per cent of positive reactions.

In the chromium plating industry Langley believes that the dermatitis and nasal ulcers are caused by chrome-bearing spray carried into the air with the hydrogen evolved at the cathode by the electrolysis of the bath containing chromium salts.

The most common salts of chromium used in industry are

Chromium Trioxide (CrO_3) a very strong corrosive and oxidizing agent used in the dye industry

Pure Chromium used to prepare alloys.

Neutral Sodium Chromate used in making the green oxide of chromium.

Neutral Potassium Chromate which is used in dyeing and in the manufacture of inks.

Potassium Bichromate which is alkaline

Sodium Bichromate which is also alkaline and extensively used in chrome tanning in the manufacture of chromium pigments and paints as a mordant in wool dyeing especially with alizarin dyes and logwood in printing textiles, in match making, in photography in photoengraving in blue-print developing in chrome plating in synthetic dye manufacture and in the rubber industry

Chrome dermatitis occurs in the fur dyeing trade where chrome alum a compound of aluminum and potassium chromate is used for the double purpose of tanning and mordanting. Potassium bichromate is also often used in the fur industry and may cause dermatitis. Ulceration is rare in this industry because dilute solutions are used

Green rouge or chrome green (Cr_2O_3) is used for the polishing of steel and other metals.

Many workers, although not bothered by the presence of ulcerations of the skin or nasal septum may claim damages or disability from these conditions in times when work is slack and they are laid off. In New Jersey in 1932, there were suddenly [illegible] claims for compensation filed by employees in a chrome manufacturing plant nearly all of whom were laid off during the depression. Although under New Jersey Compensation Laws chrome poisoning had been compensatory since 1924 no claims had ever been filed until these workers were laid off from work. Awards a [illegible]

\$500 to each of these workers. The nasal passages were the chief location of the damage.

Trumper states that persons suffering with chrome dermatitis also suffer occasionally from severe vomiting which lasts about five to ten minutes after attempting to take food.

The prevention of dermatitis from chromium and its compounds consists in removing the fumes, spray and dust by adequate suction ventilation for processes in which these substances are evolved. Also strict cleanliness of the floors walls and machinery must be maintained. As many of the processes as possible should be totally enclosed. Workers should be protected against the inhalation of chrome by respirators or gas masks. They should be supplied daily with clean protective clothing and compelled to take shower baths after work. They should be acquainted with the hazards of their occupation so that they themselves may do all they can to guard against them.

In addition to this new workers should be medically examined to make sure they have no lesions of the skin before employment and there should be frequent medical examinations of workers to detect beginning ulcerations and dermatitis.

Protective ointments are considered of value in preventing chrome lesions. An ointment consisting essentially of 3 parts of soft paraffine 1 part of lanolin with perhaps a small amount of antiseptic such as phenol can be rubbed into the skin before work. Pledgets of cotton soaked in mineral oil or liquid paraffine may be introduced into the nostrils or a grease consisting of zinc ointment and balsam of Peru may be introduced into the nose before going to work.

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CHAPTER XV

DERMATOSES CAUSED BY CARBON, COAL TAR AND COAL TAR PRODUCTS

CARBON

CARBON occurs in Nature in three allotropic forms: the diamond, graphite, and coal. In the diamond form it has not yet been reported as a skin irritant, but lesions of the skin occur among miners of graphite and of coal.

Graphite is mined and is also made artificially. It is used in pencils, crucibles required to withstand high temperature, and when mixed with oil, as a lubricant.

Coal is used for fuel and as a source of coal tar and coke. Coal miners are affected with occupational folliculitis and furunculosis due to the coal dust and soiled work clothes. Cases of tattooing of the skin have been reported among coal miners caused by entrance into the skin of fine particles of coal.

Wood charcoal can be produced by heating wood in the absence of air. The logs or pieces of wood are piled up in large heaps and covered with earth, a few openings being left for the escape of the gases. The wood at the bottom of the heap is lighted and the whole pile allowed to smoulder for a number of weeks. All of the volatile products are lost in this manner of producing charcoal. In modern methods, the wood is heated in suitable furnaces or retorts and the volatile products are collected and become a source of acetic acid, methyl alcohol, acetone, and tar. Wood charcoal is used as a fuel, as an absorbent of gases, and to decolorize and purify liquids.

Animal charcoal or bone black is obtained by heating animal substances such as bones in closed retorts. It is used to absorb gases and decolorize substances such as sugar.

LAMP BLACK

Lamp black is a finely divided amorphous carbon obtained by the incomplete combustion of various organic substances rich in carbon. Heavy tar oils, petroleum, resins, naphthalene and pitch are the chief sources of lamp black. Soot is similar to lamp black. Workers with lamp black or soot are affected with folliculitis, keratoses, and epithelioma of the exposed parts. The folliculitis and dermatitis is especially marked when the men perspire. The soot cancer of chimney sweeps is described elsewhere.

Lamp black is used in the manufacture of printing inks, electrotypes, carbon paper, India ink, varnishes, oil colors, crayons and mascara.

Folliculitis, furunculosis epithelial proliferation, photosensitivity and melanosis may occur among workers with all forms of carbon except the diamond

COAL TAR

Coal tar is obtained as a by-product in the production of coke and of coal gas. At one time a waste and a nuisance it is now one of the most important materials in the chemical industry

More than 300 compounds have been isolated from coal tar A complete list of these cannot be given here but can be obtained in text-books on the subject. They can be classified as hydrocarbons such as benzene toluene xylene naphthalene, anthracene phenanthrene etc. oxygen compounds such as phenol cresol naphthol cumarone nitrogen compounds, such as aniline, pyridine carbazole acridine quinoline and sulphur compounds such as the mercaptans.

Coal tar and its derivatives are used in almost every branch of industry It is a source of fuels for automobiles it supplies bases for the manufacture of drugs, dyes solvents perfumery synthetic resins photographic chemicals explosives war gases synthetic tannins insecticides disinfectants, rubber accelerators and numerous other substances.

Manufacturing Process.—Although tar pitch and coke result from the distillation of wood vegetable oils petroleum and coal the coal tar of commerce is derived principally from the distillation of soft coal Soft coal is prepared for coking by first sorting out whatever slate and other foreign matter it may contain This is done by washing with water and by a process known as flotation in which the heavier substances contained in the impure soft coal are removed Preliminary treatment is not required when pure coal is being coked.

In a coal tar plant coal from various sources is first blended before being put into the coke ovens. This is done to obtain the uniform coke which is used chiefly in the steel industry The blended coke is dumped from cars into the tops of a battery of coking ovens in which the coal is heated without access to air This manner of heating drives off coal gas After the charge of coal in the oven is fully consumed, the ovens are opened and a ram forces out the red-hot coke into a receiving metal car where it is quenched with water

Fuel pitch is also heated in the coke ovens and coked. Usually a coal tar distillation plant is connected with a coke plant and the fuel pitch is pumped while hot from the coal tar plant into the coke ovens.

The gas evolved from the heated coal is sucked through a large main and cooled by washing with water This causes the tar to settle out. The water dissolves ammonia and phenol from the gas and these substances are recovered from the liquor The tar is collected and sent to the tar plant. The remaining gas is treated

with sulphuric acid and whatever ammonia remains is converted into ammonium sulphate The ammonium sulphate is dried in a centrifuge collected and stored After the ammonium sulphate has been removed the remaining oil is treated with straw oil a petroleum product which removes the light tar oil By means of fractional distillation the light tar oil is separated from the straw oil and the straw oil is used over again to dissolve more light tar oil From the light tar oil by further fractional distillation, there is obtained benzol toluol xylol and solvent naphtha.

The dust from the coke and coal produces irritation and a melanosis of the skin among exposed workers on top of the coke ovens who load coal into the ovens and take out the coke

In the coke manufacturing portion of a certain coal tar plant examined by the authors where the whole process of heating the coal was totally enclosed and there was no possibility of contact with dust from the coke no cases of dermatitis, melanosis, or photosensitivity were observed. Cases of folliculitis of the arms and legs were seen among some of the workers who allowed their clothing to become saturated with the straw oil and light tar oil

Coal tar comes to a coal tar plant either directly through pipes from a coke plant in railroad cars, or is brought in barges. It is pumped into storage tanks in such a manner that there is very little contact with the workers. From the storage tanks the coal tar is pumped through pipes to the stills where it is heated to a high degree under high pressure, resulting in the distillation of the oils and the separation of the pitch. The pitch drops into a tank and the oils are collected and fractionated in fractionating columns. The whole process is totally enclosed

Coal tar is usually distilled into three portions, light oils, middle or creosote oils and the heavy oils. In some plants however four or five cuts may be made The first cut is distilled up to 110° C and consists mostly of crude naphtha the second portion distilled from 110° to 180° C is the light oil and the third portion distilled from 180° to 240° C is the middle oil. The fourth coming off between 240° and 270° C is the heavy creosote oil and the fifth portion coming off between 270° and 340° C is the anthracene oil Pitch which comprises from 50 to 60 per cent of the coal tar is the final residue This pitch contains a certain amount of oil and a residue of coke The pitch is either sold to be used for making roads, roofing conduits etc burned as fuel or returned to the coke ovens.

The crude naphtha which comes off below 110° C constitutes from 1 to 2 per cent of the coal tar and contains crude benzol pyridine bases toluol solvent naphtha and some phenol

The light oil which comes off between 110° and 180° C constitutes from 7 to 8 per cent of the coal tar and contains crude benzol pyridine bases, toluol solvent naphtha, phenol and crude creosol The middle oil, also called light creosote coming off between 180° and 240° C. constitutes from 8 to 10 per cent of the coal tar and

contains crude carbolic acid cresylic acid naphthalene and iso-quinoline

The heavy creosote oil coming off between 240° and 300° C constitutes from 10 to 12 per cent of the coal tar and contains principally naphthalene, iso-quinoline acenaphthene and fluorene. The anthracene oil which comes off between 300° and 350° C and constitutes from 6 to 15 per cent of the coal tar contains principally phenanthrene anthracene, carbazole indole and acridine

Water gas tar differs from coal tar in the fact that to it is added a considerable amount of fuel oil This is done because water gas must have a certain standard lighting power and to obtain this fuel oil is added to the coal gas.

FIG. 20.—Coal tar acne and tumors Worker in pitch making paper conduits

The Action of Coal Tar on the Skin.—The constituents of coal tar which are soluble in the sebum of the skin stimulate epithelial cell production Coal tar is also anti-pruritic because of the anesthetic properties of the phenols which it contains. It plugs up the hair follicles and the sweat gland openings both mechanically and by inducing proliferation of the cells. Secondary infection of the acne-like lesions leads to pustule formation. It also causes the formation of keratoses and papillomata (Fig 20) and in some instances epithelioma. It is stated that the high boiling portions of tar and its pitch are the most active carcinogenic agents in the coal distillation industry Tar causes melanosis among all the workers exposed to its fumes or its dust The exposed parts are the only parts discolored and the melanosis resembles somewhat the color of sunburn The covered parts of the body may be affected by keratogenic changes, papillo-

mata and epithelioma. (See Chapter on Occupational Cancer) R. Prosser White described the characteristic appearance of the skin of workers in coal tar under the name of "shagreen skin" He states that "it occurs on the workers who have worked for many years with coal tar and begins as a patchy erythema around the follicles Certain of the areas become atrophic and there are other areas of keratoses surrounded by a red areola and flat warts are common The skin is mottled by dark spots on a general pigmentation and there are white patches of old scars and areas of local atrophy

Coal tar has a photosensitizing action on the skin. Probably all of the fractions of coal tar above the first 15 per cent are capable of producing photosensitivity This is shown by the fact that workers who are exposed to the fumes of hot road tar as they place it on the roads develop a photosensitivity which makes sunburn very easy The road tar sold by one of the coal tar manufacturing companies consists essentially of coal tar with only the first 15 per cent of the lighter fractions removed The fumes consist essentially of the heavier distillates contained in the light fraction, such as the phenols tar acids and naphthalenes Then again the workers who handle roofing pitch which consists essentially of coal tar with only 30 per cent of the lighter distillates removed also suffer from photosensitivity They are exposed to the fumes and dust which arise from the roofing pitch as it is melted The workers who handle fuel pitch are also photosensitive. Fuel pitch is a hard brittle substance which remains after 55 per cent of the volatile substances have been removed from the coal tar The workers who handle pitch are exposed to no fumes but only to the dust of the fuel pitch. Workers who are exposed to pitch oil which is obtained by further heating fuel pitch are also photosensitive so that it seems that there are photosensitizing substances in the whole range of coal tar distillates above the first 15 per cent.

A large number of the compounds isolated from coal tar have the property of absorbing certain wave lengths of the spectrum and emitting them as fluorescence Some workers develop severe cases of sunburn when exposed to the light after they have been in contact with coal tar coal tar pitch, and other fractions. Other workers develop an urticaria-like dermatitis while others may develop only melanosis Those who develop a melanosis are less susceptible to dermatitis and sunburn than those who do not New workers develop marked sunburn or dermatitis before they become melanotic but after their skin becomes sufficiently pigmented they no longer develop severe sunburn or dermatitis. However lesions such as comedones, acne keratoses, and epithelioma may occur without regard to the presence or absence of melanosis.

In the study by Foerster and Schwartz, workers with coal tar pitch were patch tested with the pitch the oil fractions distilled from pitch acridine anthracene carbazole fluorene and phenanth

rene. No positive reactions were obtained until the sites of the patch tests were exposed to sunlight and then dermatitis developed at the sites of the coal tar anthracene and phenanthrene patches on some of the workers, showing that contact with these substances had induced photosensitivity. The photosensitivity thus induced caused a dermatitis at the site of the patches on exposure to sun light filtered through ordinary window glass but no reaction followed exposure to the mercury vapor lamp. Visible light and not the ultra-violet rays, was concerned in the reaction.

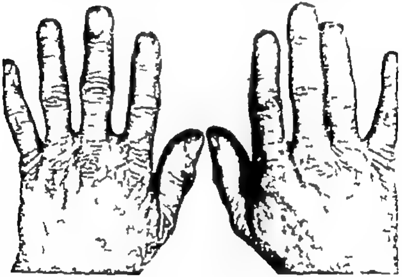

Fig. 31.—Eczematoid dermatitis from tar paint, and sunburn. (Case of Drs. Foerster and Wieder.)

Some of the workers with coal tar and pitch become so photosensitive that they cannot work in the daytime without developing a dermatitis, but they can safely work at night if they bathe after the night shift and remove whatever tar may be left on the skin and avoid excessive exposure to the light in the daytime. The experiments performed by Foerster and Schwartz show that anthracene acridine carbazole fluorene, and phenanthrene are not primary irritants but are photosensitizers which sensitize the skin to visible wave lengths of sunlight.

In a plant manufacturing naphthalene phenols, creosote pyridine and road tar all the workers showed the characteristic melanosis of coal tar workers, some more and some less. All of the workers stated that they sunburned more easily than the average person. Only those workers who were known to be particularly resistant to sunburn were permitted to work in the yard of the plant where they were exposed to sunlight at jobs such as handling fuel pitch. Two workers were seen who were exposed to pitch dust while shoveling

fuel pitch and who developed a papular erythematous eruption on the face similar to urticaria. It disappeared after they were assigned to work indoors and did not reappear while working indoors

Sunburn and peeling of the skin among workers exposed to coal tar and pitch occurs not only in the summer but also on bright days in the winter especially when there is snow on the ground which reflects the light to the face

Fig 23 —Urticarial dermatitis. Worker in yard of tar paper plant who is exposed to fumes emanating from stores of tarred paper

The conditions described above affect not only workers in coal tar factories but also those *engaged in industries where coal tar and* its fractions are handled Workers who impregnate paper tubes with coal tar pitch in the manufacture of conduits workers engaged in roofing and in the manufacture of roofing paper or roofing felt those who tar roads, impregnate wood with creosote and anthracene oil or use coal tar pitch in the manufacture of such articles as cables battery boxes and resins are all similarly affected Workers who handle creosoted wood and logs may suffer from the effects of the coal tar products Haldin-Davis reports a case of multiple warts in such a worker and Michel Bertrand *et al.* report a case of gangrene of the finger-tips.

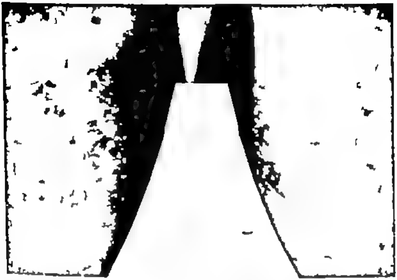

FIG. 23.—Tar acne and folliculitis. Conduit maker (U. S. Public Health Service, Dermatoses Investigations.)

FIG. 24.—Fisherman. Pustular dermatitis due to tarred fishing lines. (Case of Dr John Godwin Downing.)

COAL TAR PRODUCTS

Pitch.—Pitch constitutes the residue of the distillation of coal tar It is used for road making roofing insulation in the manufacture of briquettes varnishes, and lamp black. Pitch consists of the heavy oils of coal tar and carbon

A number of chemical constituents have been isolated from pitch the principal ones being anthracene, acridine carbazole phenanthrene,and indole Pitch dust affects the skin both chemically and physically The particles may be sharp and inflict physical trauma on the skin as well as mechanically plug up the follicular openings of the skin In addition to this pitch chemically stimulates epithelial proliferation

The skin lesions and photosensitivity described among coal tar workers, namely folliculitis (Fig 23) comedones acne keratoses, papillomata epitheliomata cutaneous atrophies telangiectases xeroderma and melanoses occur even more frequently among pitch workers. Cases of such skin lesions have even been reported among workers who use only comparatively small quantities of tar and pitch in the manufacture of other materials such as tarred ropes cork (Fig 24) bricks etc Pitch dust in some instances causes a condition similar to tattooing This has also been observed on the cornea and conjunctiva

ASPHALT MINERAL PITCH, HARD BITUMEN

Natural Asphalt consists of earth and rocks impregnated with bitumen

Bitumen is the solid product derived from slow oxidation of organic matter It is a solid or semi-solid black combustible mass

The Trinidad Lake is the largest deposit of natural asphalt Other deposits are found in Switzerland Italy France United States, Mexico Russia, and the Dead Sea.

Distilled asphalt yields oils used as fuel and lubricants Asphalt is used for road making roofing as an antirust in paints as an electrical insulator

Asphalt can cause dermatitis and acne-like lesions as well as keratoses similar to that caused by tar but not as severe The greenish-yellow fumes given off when asphalt is boiled can cause photosensitization and melanoses. Artificial asphalt is a mixture of tar pitch coke limestone and sand.

Workers with asphalt should adopt the same preventive measures as those described under coal tar

Artifical asphalt consists of a mixture of coal tar pitch and anthracene oil. The skin lesions produced by it are similar to those produced by its constituents.

Briquettes.—Briquettes are made by mixing coal dust and pulverized pitch, then heating the mixture to melt the pitch distributing the heated mass into molds and then compressing it The workers

who break up or pulverize the pitch into fine particles to form the powder and those who mix the coal dust with the pitch are the ones principally affected with folliculitis, acne pitch warts and pitch cancer

After the pitch powder and the coal have been mixed the process is further carried on in an enclosed apparatus where the mass is moist owing to the steam which is used to melt the pitch The workers on the briquette presses do not suffer as much from skin lesions as those exposed to the pitch dust. However the photosensitivity induced by pitch seems to be present among all workers exposed to it even slightly

Briquettes are but little used in the United States.

Creosote Oil.—The heavy creosote oil is used in wood preserving railroad ties telegraph poles piling for piers wooden blocks for flooring are all impregnated with creosote oil under pressure in order to preserve them from insect and fungi and the ravages of damp earth and water

Workers engaged in impregnating wood with coal tar pitch are affected with photosensitivity melanosis, coal tar acne keratoses and epithelioma. Workers handling wood impregnated with coal tar pitch are subject to the same hazards

Dermatitis has also been reported as occurring on the ankles and legs of employees working on floors composed of freshly creosoted wooden blocks. A week or two of exposure was necessary before itching and a papular vesicular eruption appeared above the shoe tops and extended 4 to 5 inches up the legs. The dermatitis was attributed to the fumes of creosote coming off the wooden blocks. As the floors became older the odor of creosote noticed at first disappeared and no more cases of dermatitis occurred

Acridine.—Acridine ($C_{13}H_9N$) is prepared from the heavy coal tar oils In the pure state it is a yellowish-white crystalline substance with a melting-point of from 107° to 111 C and soluble in water alcohol ether and the hydrocarbons. It is used in the manufacture of synthetic dyes especially leather dyes. It can be placed on the skin when pure and left on as a patch test for twenty four hours without causing a reaction but it does photosensitize the skin Impure acridine however is said to cause inflammation and itching of the skin as well as violent sneezing Amidophenyl acridine or phosphine a yellow leather dye is a skin irritant

Anthracene —Anthracene ($C_{14}H_{10}$) is obtained from the anthracene oil of coal tar The crude anthracene cake contains about 40 per cent of anthracene and smells strongly of creosote and phenol When purified it appears in the form of white crystals. If placed on the skin in this form it can remain on as a patch test for twenty four hours without causing a reaction It does however photosensitize the skin of a considerable percentage of workers.

Those who handle crude anthracene or anthracene oil suffer from skin affections described under coal tar and pitch

Anthracene is used in the manufacture of synthetic dyes and in

the preparation of anthraquinone Anthracene oil is used as a preservative for wood and is sometimes added to machine oils.

Phenanthrene —Phenanthrene ($C_{14}H_{10}$) is an isomeride of anthracene When pure it forms shiny colorless scales soluble in ether but only very slightly soluble in water It is a photosensitizer but does not in the pure state irritate the skin It can be left on for twenty-four hours in the form of a patch test without producing a reaction

Naphthalene.—Naphthalene ($C_{10}H_8$) is obtained from that portion of coal tar which distills between 170° and 230° C Before it is refined it is dirty yellow in color from mixture with creosote oils and causes dermatitis. In the pure state it is white and flaky and volatilizes even under ordinary temperature but only rarely causes conjunctivitis and irritation of the mucous membranes.

Naphthalene is used principally in synthetic dye manufacture as a moth killer and in varnishes and antiseptics. It is also nitrated (see Explosives) and chlorinated (see Resins and Waxes)

Pyridine —Pyridine (C_5H_5N) is a colorless liquid with a disagreeable odor boils at 115° C and is used in the preparation of indanthrene coloring matters and anthraquinone to denature alcohol and as a solvent It is prepared from coal tar after extraction of phenol and naphthalene. It can also be manufactured synthetically by oxidation of quinoline

The fumes of pyridine irritate the mucous membranes . Being a fat solvent it causes dryness and cracking of the skin It also causes photosensitivity as described under other coal tar compounds

PREVENTION OF DERMATITIS FROM COAL TAR

The prevention of dermatitis from coal tar and its derivatives consists essentially in having totally enclosed processes, adequate exhaust ventilation and cleanliness of the work rooms and the workers. Adequate shower baths should be provided and the workers compelled to use them after work and clean work and under clothes should be provided daily There should be periodic medical examinations for the early detection and treatment of dermatitis and new growths of the skin.

Protective ointments are of use when the workers are exposed to fumes of coal tar or to the dust of coal tar pitch or their derivatives

Such protective ointments should have incorporated in them a powder which is opaque to the sun rays such as titanium dioxide and a chemical which prevents the penetration of the burning solar rays. Such chemical light screens are salicylates, anthranilates derivatives of cinnamic and tannic acid etc (see Cosmetics Light Screens)

Workers who are photosensitive may be transferred to the night shift or to departments of the plant where they are not exposed to coal tar or its photosensitizing compounds.

Personal cleanliness prevents and cures folliculitis and furunculo-

ma caused by coal tar and its derivatives In addition to cleanliness antiseptic dressings such as mercuric chloride 1 5000 or antiseptic ointments such as sulfathiazole 5 per cent or penicillin containing ointments may be used.

Comedones and acne-like lesions or cysts should be manually evacuated either by expression or incision and expression. X-ray is contraindicated

Keratoses, papillomata and epitheliomata should be removed as soon as discovered The knife and radium are the methods of choice It is rarely necessary to remove adjacent lymph glands when removing skin cancers caused by coal tar

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CHAPTER XII

DERMATOSES CAUSED BY PETROLEUM

THE geological occurrence and the chemical nature of petroleum supports the theory of its organic origin. There is no general agreement however on the method by which petroleum was formed. Both the theories of anaerobic fermentation and destructive distillation of animal and vegetable matter have been advanced. It seems likely from the differences in the chemical character of the various crudes obtained from different fields that the several varieties of crude petroleum have been produced by somewhat different natural processes and from different organic materials.

Crude petroleum as it issues from the wells consists mainly of a mixture of various hydrocarbons a small proportion of compounds of oxygen nitrogen and sulphur with gas water clay and inorganic substances held in solution or suspension.

Crude petroleums have been roughly classified into three classes. Those having a paraffin base such as Pennsylvania crude petroleum, those having a naphthenic base such as Northern California petroleum and those having an asphaltic base such as that from the Gulf Coast in Mexico. The different varieties of crude petroleum however nearly all contain the same substances differing only in the proportions of these substances. Therefore Cruse divides the crude petroleums into four classes (See Petroleum and its Products published by McGraw Hill Publishing Company Inc., New York 1928) and classifies them in the form of a triangle with the paraffin aromatic and asphaltic bases at each apex and the naphthenic base placed in the center of the triangle. Lines running from the apices to the center represent the bases of crude petroleum obtained from the various fields throughout the world.

Dermatitis occurs among workers in the oil fields and is termed oil poisoning. According to Adams and Irby a search of the literature and correspondence with physicians practicing in the oil fields did not reveal a single case of contact dermatitis proven to be due to crude petroleum. They therefore conclude that dermatitis due to crude petroleum must be very rare and that most of the cases termed oil poisoning are probably due to some other cause. They themselves however report a case which they proved by patch tests and rapid occupational tests to be due to hypersensitivity to certain varieties of crude petroleum.

However Mierzecki reports that a grayish-brown pigmentation on the hands and forearms occurs among workers in the Polish petroleum fields and he concludes that it is probably due to the photosensitizing effect of the naptha-hydrocarbons. He also reports small pigmented warts on the forearms of these workers.

Diseases of the skin among workers in oil refineries are well-known. Scott reports that in the Scottish Shale oil refineries he found the workers affected with comedones folliculitis pustular dermatitis papular dermatitis, erythema, and epithelioma. He states that a warty condition usually precedes malignancy and that the malignancy may develop years after the worker has been removed from contact with crude oils or paraffin. He gives the incidence of cancer among these workers as 0.1 of 1 per cent per annum and states that the hands the forearms, and the arms were the parts mostly affected among paraffin workers and the scrotum among oil workers

Lyth states that the refractivity and iodine value of an oil is a probable indication of its carcinogenicity When the refractivity is less than 0.5500 the oil is non-toxic, but if the refractivity is greater than 0.5600 the oil is highly toxic. If the iodine value is above 26 the oil is likely to be toxic but if the iodine value is above 30 it is almost certain to be toxic

According to Ullmann the carcinogenic principle in crude petroleum is found principally to be in the range of the distillate which comes off between 250° and 350° C. under normal pressure. He states that this principle is not absolutely carcinogenic because it produces cancer only in certain animals and predisposed individuals.

Wood states that pure petroleum is inert and is in no way deleterious to health and that dermatitis and folliculitis in petroleum workers is not caused by pure petroleum although Steiger Kazal reports a case of verrucous dermatitis occurring at the site of a benzine burn which was treated with a spray of pure paraffin.

Twort, in his extensive experiments on mice found that the applications of oils and tars was followed by hyperplasia of the surface epithelium and inflammation of the corium with a marked tendency to the formation of multiple epitheliomas. He also noted that the formation of tumors increased progressively with the number of applications. He thinks that the benzenoid hydrocarbons of the oil are the carcinogenic agents and that treatment of the oils with sulphuric acid destroys their carcinogenicity as does oxidation and reduction. He also found that shale oil produced carcinoma twelve times as frequently as other petroleum oils and that the high boiling fractions of petroleum were thirty-one times more active in the production of cancer than the low boiling fractions.

The authors studied eight oil refineries employing about 14,000 people of which number 4,500 were actually examined for the occurrence of dermatitis. These refineries used all the various varieties of crude oil obtained in North and South America including Pennsylvania California Ranger Mid-Continental Mexican Peruvian Venezuelan, and Texas oils containing paraffin asphalt, naphthenic and mixed bases. The character of the various crude and final products desired determines the manner in which they are treated

During the three-year period from 1937 to 1940 55 cases of

dermatitis mostly due to petroleum distillates used for cleaning the hands have been reported to the California State Industrial Accident Commission by physicians employers, and carriers of workmen s compensation insurance There have been no reports of epitheliomas among oil field workers during this period

The Labor Code of the State of California of 1937 requires that every employer insurer and physician and surgeon who attends any injured employee shall file with the Commission under rules and regulations prescribed by the Commission a complete report of every injury to each employee arising out of or in the course of his employment unless disability resulting from such injury does not last through the day or does not require medical service other than first aid treatment.

This law was evidently intended to include the reporting of all occupational dermatoses, but leaves a loophole for the physician s failure to report such cases by permitting him to state that he thought the disease was not of occupational origin This may account for the fact that the epitheliomas occurring among oil field workers were not reported to the State Industrial Accident Commission

An investigation was undertaken by the senior author for the purpose of determining what effect the California crude oil and excessive sunlight have on the skin of exposed California oil field workers.

Oil was discovered in California about sixty years ago by a young geologist from Pennsylvania who found oil seepage in the mountains near Newhall. The first wells were comparatively shallow were dug by the primitive spring-pole method and yielded only about two barrels a day Later geologists by studying the surface contours and geologic formations were able to determine fairly accurately the location of not too deeply situated oil bearing sands At present all such places of surface seepage and shallow oil bearing sands in California have been exploited and reliance for the discovery of new oil fields is now placed on the seismograph This instrument records variations in the vibration of an area elicited by exploding dynamite charges buried in the earth Oil bearing strata three miles below the surface can be detected by such methods. To discover such deep wells requires considerable capital and to dig one costs an estimated $10 per foot of depth so that only the large oil companies can now afford to prospect for oil

Wild cats or wells sunk into unproven fields by independent prospectors, are now rare Many of the present wells can yield several thousand barrels of oil per day but their present output is restricted by Government regulations. The oil obtained from California fields is mostly asphalt base but naphthenic and paraffin base crudes are also occasionally found in this State

The examination of workers in the oil fields requires the cooperation of the large oil companies. This was obtained after the purpose of the study was explained to them The men in the oil

fields work over large areas and in order to examine them at their places of work considerable distances must be covered Some of this travel was over high mountains and some over large areas of desert. The oil companies instructed the heads of the various districts to assist in this work by having the men congregate in as large groups as possible in central locations, either before beginning work in the morning or during the lunch hour or before going off shift. Such gatherings were usually held in small frame structures which for some unknown reason are called dog houses.

Because we were trying to find the effect of crude oil and sunlight on the skin of the workers and because all the outdoor workers living in that territory were exposed to excessive sunlight it was decided to examine only those workers who are more or less exposed to both of these agents. Accordingly only rig builders drillers well pullers pumpers and gangers and field maintenance men were examined

The rig builders construct new derricks and take down those derricks which will no longer be used In the latter operations they are exposed to old lumber covered with crude oil

Well drillers operate the drilling equipment which sinks the well shaft. These men come in contact with crude oil only for a brief period when oil is struck.

Well pullers maintain the flow of oil in producing wells by removing clogged or leaking pipes pumps, and pump rods and repairing them when necessary They have more contact with crude oil than any other class of worker

Pumpers and Gangers service and maintain pumping equipment measure the oil in tanks and make physical tests of crude oil for water content and other impurities. These men come in contact with small quantities of crude oil in the test tubes and with the reagents used in testing

Roustabouts and field maintenance men lubricate maintain and repair oil field machinery and equipment These men sometimes come in contact with a considerable amount of crude oil

Of 743 oil field workers examined 140 were found to have keratotic lesions on the hands forearms face, or neck. Most of these keratotic lesions consisted of slightly elevated flat brownish growths on the skin some showed ulceration and scab formation which may have resulted from the worker picking them or form degenerative changes in the lesions themselves.

Seven of the 743 men examined were found to have epithelioma on the exposed surfaces of the body The epitheliomas were characterized by ulceration and induration as well as by chronicity Some of them were multiple and recurrent

Six cases of acute dermatitis were found These were characterized by vesicle formation crusting erythema and desquamation. The affected workers attributed these lesions to the petroleum solvents, such as pearl oil and Stoddard s solvent which they used for cleansing their hands. In addition to these cases many men were

found whose hands showed a glistening parchment-like appearance and a thickened skin leather like to the feel. There were freckle spots of hyperpigmentation interspersed with areas of depigmented skin. This condition of the skin is also probably caused by the effect of exposure to the sun and the petroleum solvents which the men use to clean their hands.

Other skin conditions found include one case of oil folliculitis of the thighs one case of lupus erythematosus of the face one case of psoriasis and one of multiple lipomata.

Table 4 shows the number of workers examined in each occupation classification and the number of cases of epitheliomas found. There were 7 cases of active epitheliomas found among 743 workers examined These do not include a foreman who had had an epithelioma of the nose removed by radium five years previously without recurrence.

TABLE 4.—OCCUPATIONAL TABULATION OF OIL FIELD WORKERS EXAMINED

Occupation	No Examined	No Epitheliomas
Rig builders	39	1
Well drillers	129	0
Well pullers	209	6
Pumpers and gaugers	44	0
Roustabouts and field maintenance men	322	1
Totals	743	7
Number of keratoses 146. Per cent of keratoses 19		

It will be noted from this table that among the well drillers who have practically no contact with crude oil no cases of epithelioma were found. This is also true of the pumpers and gaugers. While the latter workers handle crude oil in small quantities in testing it for water content they usually wear gloves to protect themselves from the action of the carbon bisulphide and cresylic acid which are used as reagents to break down the emulsion of water in the crude oil. This also protects them from the oil It will be noted that among 209 well pullers examined 5—or about 2 5 per cent—had epitheliomas. These are the men who are most exposed to crude oil They usually work with bare hands and handle the crude oil soaked pipe as it is hauled up from the well and subsequently replaced. One case was found among field maintenance men These workers may at times have considerable contact with crude oil One case was also found among the rig builders. These men as a rule do not come in contact with crude oil except during the demolition of old derricks but they are exposed to strong sunlight for long periods of time

Table 5 shows a further breakdown of the cases of epithelioma. It will be noted that 5 of the 7 men with epitheliomas are blonds although the blonds were only a small minority of the total number of workers examined From this table it will also be seen that the age group in which the cases occurred is the usual one for such lesions that is, from thirty-six years upwards, and that the exposure

to crude oil varied from nine to thirty years before any lesions were noticed.

TABLE 5

Case No.	Occupation	Age	Complexion	No. yrs. in oil fields	Years of exposure before appearance of lesion	Site of lesion
1	Tank cleaner Well puller	36	Blond	15	10	Neck, face
2	Well puller	44	Brunette	20	19	Dorsum, left hand
3	Well puller	58	Brunette	31	30	Dorsum, left hand right side of nose
4	Well puller	50	Blond	19	9	Inner canthus, right eyelid (recurrence after removal)
5	Roustabout	48	Blond	17	15	Dorsum left hand
6	Well puller	50	Blond	37	20	Left cheek left side of nose
7	Rig builder	40	Blond	15	12	Left side of neck

One foreman, who had had an epithelioma of nose removed by radium five years previous, without recurrence or appearance of other lesions, not included in this table

It was noticed that most of the abnormalities in the skin occurred among the blonds. Most of those blonds who were exposed to the sun had on their faces dilated capillaries and telangiectases and many of them had cheilitis and leukoplakic areas on the lips There were many blonds among the well drillers who are much exposed to the sun but most of the well drillers wear gloves and their hands are comparatively clean and require less washing with the petroleum solvents than do the hands of the well pullers. Consequently there were very few abnormalities of the skin found among them Although the well drillers are exposed to drilling and to "rotary muds most of which consist of clay mixed with alkalies such as soda ash lye and sodium silicate together with quebracho and barium oxide and to cement dust used in the concrete which they pour down the well to firmly fix the casing on the oil bearing sand only one case of dermatitis due to these alkalies was found among them (Other muds used consist of liquid asphalt lampblack and oyster shells ground to a powder)

During certain seasons of the year the workers in the oil fields are attacked by swarms of gnats, the bites of which are quite troublesome Many of the maintenance men and roustabouts who clear away brush and weeds as a fire prevention measure also develop rhus poisoning

In order to determine the incidence of epithelioma and keratoses among the general population of the oil bearing portion of the San Joaquin Valley the records of the Kern County Hospital were examined The population of the County is about 130,000 and there are two other hospitals but the Kern County Hospital has more patients than the other two put together In the fiscal year 1938–39 13 187 new patients passed through the hospital. Of

We are indebted to Dr Joe Smith County Health Commissioner for the following figures.

these 189 were diagnosed as carcinoma of the exposed portion of the skin or about 1 4 per cent 128 were males, and 61 were females. Of the 128 males 71 were oil field workers or laborers whose work may have involved contact with petroleum in the oil fields whereas only 20 were engaged in occupations such as rancher gardener and farmer in which there was exposure only to excessive sunlight.

In view of the facts revealed by this study it is suggested that in selecting new employees for outdoor work in the oil fields of California marked blonds should not be chosen Those blonds who are already employed should wear hats shading their faces and necks and long sleeves and gloves to protect them from the action of the sun As additional protection they might also use on exposed skin surfaces a protective ointment consisting of a mixture of an animal and vegetable oil such as lanolin and olive oil into which chemical and physical sun screens such as quinine salicylates and zinc or titanium oxide have been incorporated

The use of strong alkaline abrasive soaps and of petroleum solvents for cleaning the hands should be avoided A sulphonated vegetable oil such as sulphonated olive oil or sulphonated castor oil should be provided for cleaning the grease and crude oil from the hands This could then be washed off with ordinary toilet soap and water All workers whose hands become soiled with crude oil or petroleum distillates in the course of their work should be required to rub into their skin an ointment of equal parts of lanolin and castor oil before going to work, in order to fill the pores of the skin with this mixture and prevent the entrance of the crude oil This cream may be washed off with a sulphonated vegetable oil followed by soap and water Those workers whose skin is dry and shows a fat deficiency should after washing with soap and water again rub into their hands a mixture of lanolin and olive oil to replace whatever fat may have been taken out of the skin

The workers seen during the course of this study were exceptionally clean in their habits most of them take baths every day Pyogenic lesions of the skin such as folliculitis and boils were noted in only one worker Nevertheless it would be advisable for the well pullers to wear coveralls made of pliofilm vinylite or koroseal which are oil-proof in order to prevent the soiling of their clothes by crude oil and distillates.

The testing of the crudes should be done under ventilating hoods in order to avoid the hazard of carbon bisulphide poisoning The pumpers and gaugers who make these tests should wear rubber gloves to prevent burns from carbon bisulphide and cresylic acid

Well drillers rig builders, and roustabouts should be supplied with leather gloves and well pullers and pumpers and gaugers with rubber gloves The rubber gloves should be fabric lined in order to prevent the clamminess which results from the wearing of rubber gloves in warm weather

A similar study made in the oil fields of Southern Texas in which 330 workers were examined did not show a high incidence of epi

theliomas or dermatitis. The wells in southern Texas are free flowing therefore pumping and well pulling are not necessary Derricks are few and far between After a well is brought in, there is but little contact with oil These factors may account for the comparatively lower incidence of dermatoses among the workers in the south Texas oil fields.

In general the petroleum is distilled in batteries of crude stills and a number of cuts are made at different times in the distillation process. The number of cuts depends on the kind of crude and the products desired The most common cuts made are called

1 Gas, which contains ethane propane and butane. By the application of cold and pressure a certain proportion of this gas can be liquified A liquified butane is used as a refrigerant and a liquified pentane is used as a local anesthetic. Hexane comes off at about 60° C and is used as a rubber solvent The fraction coming off between 70° and 120° C. is known as benzine and is to be distinguished from benzene or benzol Benzine is used for dry cleaning and also as a motor fuel

2. Naphtha, or crude gasoline, from which stock all grades of straight run gasoline are made This cut comes off below 150° C Petroleum naphtha must be distinguished from solvent naphtha which is used as a rubber solvent and is obtained from light coal tar oil and consists of mixtures of toluene xylene and pseudocumene

3. Water White or crude kerosene which is the base for painters naphtha and turpentine substitutes and all grades of kerosene and mineral seal oil

4 Gas Oil the next heavier product is a somewhat discolored non-viscous oil which is used to a great extent in the cracking process for the production of gasoline and kerosene

5 The next heavier distillate is paraffin distillate which of course is only obtained from crudes having a paraffin base. Paraffin distillate is a highly discolored oil of medium viscosity which upon subsequent refining yields paraffin wax and lubricating oils.

6. Whatever is left in the stills after the above fractions have been distilled is known as coke Certain grades of crude petroleum are distilled in coke stills (which are large iron cylinders) and the residual product of this distillation is coke Crudes with an asphalt base leave as a residual product the asphalt which is used for road building

Some of the heavier distillates such as gas oil and even crude kerosene are "cracked" to yield gasoline Cracking is usually done by rapidly passing the oil through tubes heated to from 400° to 500° C under high pressure Gas, gasoline residual oil and coke are the products of cracking and the gasoline obtained in this manner differs somewhat from gasoline obtained by the distillation process.

In order to meet the various market specifications, gasoline and kerosene are treated to remove certain deleterious materials such as asphalts, resinous substances, and compounds of oxygen, nitrogen

and sulphur The chemicals used in the treatment of gasoline kerosene, and oil are sulphuric acid caustic soda Fuller's earth liquid sulphur dioxide, and lead oxide. After the acid treatment which takes place in large cylinders the product is washed in water and neutralized with caustic soda and then filtered through Fuller s earth before it is ready for the market Sometimes the characteristics of the sulphur compounds remaining in the distillates make it necessary to combine neutralization with a process called sweetening Before the sweetening process the product has a certain sourness due to the presence of hydrogen sulphide or "mercaptans The chemicals used in sweetening are caustic soda litharge and flowers of sulphur in one method and in another method sodium hypochlorite and chloride of lime are used.

Fig 25 —Wax warts paraffin pressman

Paraffin is obtained from the paraffin distillate which is put under pressure and cooled at the same time in an apparatus called a plate press. The wax collects on the plates in in the press and when a sufficient amount has collected the press is opened, the plates are taken out and the wax is scraped off It is in this process that by far the largest percentage of wax warts, wax comedones acne boils and epitheliomata occur (Fig 25 and Fig 26)

The wax taken off the plates is of dark brown color and is with considerable quantities of oil It is further purified by liquifying it in shallow pans, then allowing it to cool until it solidifies, and then slowly raising the temperature to allow the oil to "sweat out. The apparatus in which this purifying process is performed is called the "sweater This "sweating" is repeated until the paraffine is pure and then it is further purified by filtration through bone black. It is then molded to form The percentage of cases of wax warts acne epithelioma, etc. among the workers decreases in direct proportion to the purity of the paraffine they handle and workers

handling the white refined product are practically free of these conditions.

Certain low grade petroleums are put directly into cylindrical stills known as coke stills. After the stills are run for a while and whatever distillation products come off are recovered coke is left in the still The residual coke is removed in one type of still through a manhole The men enter this as soon as the still is cool enough and break up the coke and shovel it out. This is a hazardous operation because of burns and scalds and poisonous gases. Colored men have been found to stand up under this work better than white men On the hands of white men who do this work there can usually be found telangiectatic spots as a result of burns and the heat as well as keratoses. This has not been noted on the skins of colored workers.

FIG. 28.—Paraffin tumor of scrotum of wax pressman.

A less hazardous type of coke still is one which has the lower half of the ends of the cylinder in the form of a hinged door which can be opened up exposing the floor of the still. Before such a still is filled with crude oil there is laid on the floor of it a series of diamond-shaped iron grates connected with steel chains. These become embedded in the coke as it forms. When the still is opened a cable is attached to the chain holding this grating and by means of a winch the bed of coke is loosened and broken by the traction on the cable

There are also coke ovens in some of the refineries which make coke from the remnants and tailings of the distillation process. This is done by heating the tailings in brick-lined ovens. Some

light gas is recovered drawn off and mixed with the lighter distillates Such coke ovens have removable ends which can be opened and the coke removed by powerful rams.

Certain refineries have their own modified methods of distillation. For instance in one refinery the lubricating oil is distilled over hot mercury vapor The hot mercury is totally enclosed so that none of it can escape and cause mercury poisoning in the workers. Selenium indicators in these rooms detect and record the presence of minute fractions of mercury in the air

Some of the refineries manufacture various by-products such as soaps greases candles wax products and insecticides. Greases are manufactured by mixing soap and lubricating oil in various proportions according to the consistency of the grease desired As a generality the more soap used the harder is the grease

Candles are made either by molding the paraffine in suitable forms or in the old way by dipping the wick into molten paraffin and allowing it to take on a coat and then re-dipping it a sufficient number of times to give the desired thickness Oleic acid stearin inorganic and aniline dyes are used in the paraffin

Combinations of naphtha and carbon tetrachloride are also manufactured and sold as cleaners. The mixing apparatus is totally enclosed so that the workers are protected from the fumes of carbon tetrachloride

There were no marked differences in the skin conditions found in the various refineries using different crudes except in the case of crudes with a paraffin base Among 11 000 men employed in three refineries examined there occurred 100 cases of dermatitis of industrial origin over a period of two years. In one other large refinery where more complete sickness records were kept they disclosed that out of 10 625 treatments given in a dispensary over a period of twenty-nine months there were 98 cases recorded as industrial dermatitis. During this same period there were 232 cases of dermatitis treated that were recorded to be of non-industrial origin of which number 104 were diagnosed as eczema with no etiology given By far the larger number of cases of dermatitis of industrial origin were due to acids and alkalis. Although such distillates as naphtha gasoline and kerosene are powerful fat solvents and will cause dermatitis on most people if allowed to stay in contact with the skin for a sufficient length of time there were no cases of dermatitis in these refineries attributed to the action of petroleum or its distillates. This is probably due to the modern totally enclosed methods of refining in which the worker does not come in contact with any of the materials from the beginning to the end of the process.

About 10 per cent of all the employees who work in the oil refineries and whose hands are usually covered with dirt and grease were found to have on the dorsum of the hands, on the forearms and sometimes on the legs many pin-head to pea-size flat slightly pigmented papillomata or keratoses (Fig 27) These papillomata or

curred even in larger percentages among machinists, mechanics and general laborers in the plant, but the incidence was reduced to about 10 per cent when other personnel whose hands were not soiled by their occupations were included in the count. The warts and papillomata are similar to those that have been described among workers with tar. The telangiectatic spots found on the workers around the coke stills are round erythematous macules varying from pin-head to dime-size which disappear on stretching the skin. The workers stated that they were caused by exposure to hot coke when cleaning the coke from the old style stills. Some of the workers stated that they were caused by immersing the hands in hot paraffin during the "sweating out" process. Among 4,507 workers

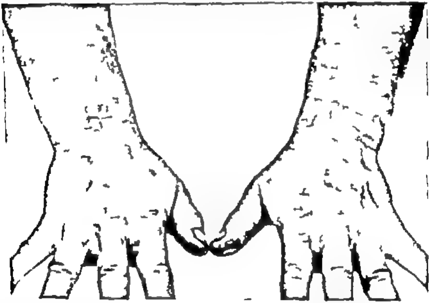

FIG. 27.—Pigmented keratotic growths occurring on about 10 per cent of workers in oil refineries.

actually examined 12 cases of epithelioma were noted. Nine of these were on the face, 1 was on the hand and 1 was on the ear and 1, in the case of a wax pressman, was on the scrotum. This last case also had one on the dorsum of the hand.

Three of the refineries examined manufactured paraffin wax and 81 of the men working on the wax presses were examined. There were found amongst them 10 workers suffering with boils (Fig. 28) or acne and 25 with the characteristic wax warts on the hands and forearms. The wax warts differ in appearance from the papillomata described as occurring among workers in oil, dirt and grease in that the wax warts are non-pigmented, elevated and slightly verrucous. The oil and wax acne differs from acne vulgaris in the fact that it occurs among workers well above the acne age and is more

common on the arms shoulders, body and legs than on the face *It is formed by the paraffin or grease plugging up the orifices of the* hair and sebaceous follicles and first forming a comedone beneath which plug a cyst forms As this becomes infected by rubbing in dirt from dirty clothes or towels, suppuration sets in and a boil results.

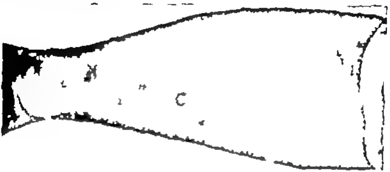

Fig 28 — Wax boils on arm of paraffin presser.

Burns are of frequent occurrence in petroleum refineries* and they constitute a large percentage of skin afflictions. Burns occur from sulphuric acid used in the treatment of the oil from the caustic soda used to neutralize the acid from the hot coke encountered in cleaning out coke ovens and stills, and from explosions and fires. In that portion of the plant where the oil is treated with sulphuric acid and in that portion where the sulphuric acid is recovered and reconcentrated the danger from acid burns is greatest. When *sludge is cleaned from the acid tanks men doing this work (usually* negroes) wear complete suits of rubber including boots clothes hats, goggles and gas masks to protect them from the acid and *the fumes. When they come out of the tanks they are required to* immediately go under a shower bath still clothed in their protective suits so as to completely wash off any irritants which may adhere to the clothes.

The tanks in which the acid oil is neutralized by the action of caustic soda also require periodic cleaning and the men entering them for this purpose are protected in the same manner as those cleaning the acid tanks because there are caustic soda deposits on the sides of the tank and in the sludge If such protective clothing is not worn burns and dermatitis occur on the exposed parts of the body Cases of chronic dermatitis which were caused by caustic deposits in pipes leading from the neutralizing tanks were seen among some of the maintenance crews in the refineries. These men were required to inspect, repair and clean out the pipes and did not wear proper protective gloves.

* Anhydrous hydrofluoric acid is used as catalyst in the manufacture of 100 octane gasoline Severe burns are caused by it. (See Anhydrous hydrofluoric acid.)

Workers going into tanks used for storing crude oil and heavy oils especially those remaining after the cracking process, for the purpose of cleaning them often become photosensitized and develop dermatitis. Certain crude oils contain photosensitizing substances but the heating of the crude oils to high temperature in the cracking process causes the formation of some new compounds similar to those photosensitizers which are formed in the heating of coal in making coal tar

In the portion of the refinery where metal oil barrels are cleaned a solution of caustic soda is used for this purpose and cases of dermatitis of the forearms and hands occur in hypersensitive workers.

Only occasionally is there an employee who becomes sensitized to petroleum distillates and develops a dermatitis. Such cases are rarely seen in the inspection of the refineries because they are usually assigned to other occupations in the plant or leave the refinery of their own accord and seek work elsewhere.

Dermatitis occurs among the users of petroleum and its distillates. Probably those most frequently affected are machinists and mechanics using cutting oils. This is described in another chapter However it can be stated that the principal types of dermatitis from lubricating and cutting oils are the eczematous types which are rare, the papillomatous formation described above and in some instances a melanosis which may be due to a tar or pitch ingredient in the oils and folliculitis and pyodermias which are by far the most frequent lesions among machinists and mechanics and which are due not only to the oils, but also to the small particles of metals which the cutting oils contain after they have been used, and which wound the skin of the workers and allow the entrance of pyogenic organisms. The oil-soaked clothing against the skin causes acnes and Wedroff and Dolgoff have succeeded in actually producing the swelling of follicles by applying compresses of oil. The swellings developed into definite acne after sixteen days.

In the manufacture of safety glass and in the manufacture of phenol formaldehyde resin, the products are immersed in hot petroleum oil and workers have developed folliculitis and dermatitis from the oil-soaked clothing which they wear (See Synthetic resins and glass.)

Dermatitis from gasoline and kerosene among garage men and gasoline service station attendants is also of frequent occurrence Johnson describes a case in such a worker which was caused only by ethyl gasoline Biederman reports a case where after repeated applications of gasoline to the forearms not only was a localized dermatitis produced but on the thirteenth day there developed a generalized dermatitis showing that the gasoline can be absorbed and affect areas of the skin with which it does not come in direct contact.

Tetra ethyl lead is made by the action of ethyl chloride on lead sodium alloy Ethyl gasoline contains about 0.03 per cent of it together with 0.02 per cent of ethylene dibromide a powerful skin

irritant which is added so that the metallic lead resulting from the combination can form lead bromide and be eliminated from the motor in the exhaust It is believed that the cases of dermatitis reported as caused by ethyl gasoline are due to its content of ethylene dibromide rather than to the tetra ethyl lead

A G Kammer and R. H Callahan describe dermatitis in a steel plant which was due to a substance known as torch oil which is a form of kerosene.

Dermatitis from the cleaning fluids made from petroleum distillates also occurs among dry cleaners of clothes and fabrics.

Mule spinners cancer occurring in England is said to be due to petroleum oil used to lubricate the spindles on the mule frame in the process of spinning yarn It has not been found to occur in the United States. *Mule spinners cancer is thought to be due to the* carcinogenic agent present in Scotch shale but is not found in the United States where shale oil is not used for lubrication

Petroleum oil and its distillates are also used as insecticide sprays on trees and other plants and dermatitis has resulted among hypersensitive sprayers.

PREVENTION OF DERMATITIS FROM PETROLEUM

Most of the petroleum refineries provide safety appliances for the prevention of burns from acids caustics and coke in the form of rubber suits goggles and gas masks. Many of the refineries also have shower baths conveniently placed in many parts of the plant so that when a worker is burned he can step immediately under the shower which operates automatically the instant a person steps underneath There are also large bath tubs kept constantly filled with water and stored throughout the yard so that a man who is burned can immediately plunge into the water

Coke stills with removable ends instead of manholes and with mechanical means of cleaning out the coke such as grates and rams heretofore described lessen the hazards in these operations

The papillomata, acne and wax warts occurring among the workers can in a large measure be prevented by compelling the men to wash their hands with soap and water before going to work, rubbing in a bland ointment such as lanolin, washing this off with soap and water before eating lunch reapplying it immediately after lunch and removing it immediately upon finishing work for the day and leaving the plant The wearing of synthetic rubber gloves over such applications of ointment is also of value

Twort advises that workers in mineral oils should rub into the skin before going to work an ointment consisting of a mixture of equal parts of anhydrous lanolin and olive oil This ointment is to be removed with soap and water after work and a small amount of it is to be again rubbed into the skin before going home Types 2A and 3 of protective ointments described in another chapter are also of value

Compulsory and supervised shower baths after work should be the rule among all workers with petroleum products and greases.

Furnishing the workers daily with clean work clothes so that they will not be compelled to use dirty rags for cleaning the grease off the skin is also recommended.

Sequeira advises the application of castor oil to exposed parts and medical inspection every three months with particular attention directed to the scrotal and inguinal regions where the majority of tumors are apt to develop.

CUTTING OILS

Cutting oils are the most frequent causes of dermatitis among machinists and metal workers.

Cutting oils are divided into two large groups, the insoluble and the soluble. The insoluble ones are used mainly as lubricants aiding the tools in the cutting operation, and the soluble ones are used mainly as cooling agents. Mineral oils and greases are also used in machine shops for lubricating moving parts and for rust prevention. These oils and greases may produce the same types of lesions as the cutting oils.

The soluble cutting oils in general consist of mineral oil about [illegible] to 95 per cent, soap about 5 to 30 per cent, and volatile matter from 0 to 10 per cent.

The mineral oil content may be a paraffin or naphthenic type of oil. The soap content may consist of sodium or potassium salts, of fatty acids, rosin, sulphonic acids or sulphonated vegetable or animal oils. The soluble oil may contain more than one type of soap and the proportions vary with individual manufacturers.

The volatile contents consist of materials which are used as mutual solvents or cutting agents which stabilize the mixture of oil and soap. They may consist of alcohol or glycol phenol, nitrobenzene, cresol, and similar materials and water. Some of these compounds serve to inhibit the growth of bacteria and fungi in the oil.

The principal function of a soluble oil is that of cooling the cutting tools so that they do not lose their temper and break or chip; the secondary function is that of lubricating. Soluble cutting oils are mixed with water in varying proportions (three to sixty parts of water per part of oil) and allowed to flow continuously over the cutting operation.

The Insoluble Cutting Oils.—Fatty oils such as lard oil—were first used to lubricate cutting tools. Since petroleum has become generally available it has been added to or substituted for these fatty oils in order to offset their high cost and their tendency to turn rancid.

Sulphur is chemically combined with the mineral oil fatty oil blend to increase the film strength and to provide the added lubrication which is needed for cutting tougher steels and at higher speeds.

The insoluble type of cutting oil consists principally of 60 to 100 per cent of mineral oil, 0 to 30 per cent of fatty oil, 0 to 10 per cent of sulphur, and 0 to 5 per cent of chlorine. The mineral oil content may be of a paraffin or naphthenic type. The fatty oil content may be oleic acid, lard oil, fish oils, and vegetable oils. The purpose of the fatty oil is to act as a sulphur carrier and to increase the lubricating properties of the oil. The presence of the sulphur enables deeper cuts to be made in the metal without harming the cutting edge. Chlorine performs, in general, the same function as sulphur but tends to cause corrosion and rusting of steel. Some base oils contain heavy chlorinated hydrocarbons.

Firms that sell the vegetable or animal oils to the cutting oil manufacturers may incorporate into them chemicals known as inhibitors, which prevent the oil from becoming rancid. These inhibitors must be of a type that will not rust iron and are frequently phenolic compounds of the type of phenolic amines. The insoluble cutting oils may also contain small percentages of these inhibitors.

Action of Cutting Oils on the Skin.—All petroleum oils have the property of defatting the skin. The defatting action is somewhat lessened by the animal or vegetable oil content of the cutting compound, but since these oils are contained in comparatively small percentages in cutting oil, their action does not altogether counteract the defatting action of the mineral oil content. All oils may plug up pores of the skin and form comedones.

The chlorine content may be sufficiently high to irritate the skin, and the presence of heavy chlorinated hydrocarbons causes chloracne of the exposed parts as well as the parts touched by soiled clothes.

The sulphur content of a cutting oil may cause a dermatitis because of the actual effect of the sulphur itself on the skin, or because the sulphur may be converted into such compounds as hydrogen sulphide or sulphur dioxide by the action of the heat generated by the cutting operation.

The animal or vegetable oils, especially when they are rancid, may irritate or sensitize the skin of some of the workers.

The phenols, cresols, nitrobenzene, and other inhibitors[1] are usually not present in sufficient amounts to be primary irritants, but they may act as sensitizers and cause allergic eczemas.

The type of skin has a marked influence on the worker's susceptibility to dermatitis from the cutting oils. A greasy skin having active sebaceous glands is less apt to be defatted than is a dry skin. A smooth, hairless skin is less apt to develop comedones than a hairy one.

Cutting oils, after being used, contain many steel slivers which may wound the skin of the workers, especially if old, dirty towels

[1] 2, 6, di-tert-butyl-4 methyl phenol, N-phenyl-1-naphthylamine, tert-amyl-phenylphosphit, N-benzyl-p-anisidine, trithiophenylphosphat are some other inhibitors for oils.

and old used waste full of slivers are employed for drying the hands

Types of Dermatitis from Cutting Oils.—Comedones of the hands and fingers occur in nearly all workers handling cutting oils unless they are particularly careful about washing their hands after work. Folliculitis and acne (Fig. 29) are the most frequent types of dermatitis caused by cutting oils. Folliculitis and acne generally occur on the extensor surface of the forearms and of the thighs where oil-soaked sleeves and trousers have closest contact with the skin. The bacteria found in the lesions are usually the pathogenic staphylococci which are usually found in ordinary boils and which may be found on the intact skin. It is true that workers sometimes expectorate into cutting oils and that the oils may even be contaminated with the

FIG. 29.—Cutting oil acne.

colon bacillus. However we believe that it is the bacteria on the skin which causes the folliculitis from cutting oils and not the bacteria which may be in the oil. The United States Public Health Service has analyzed samples of sterilized and unsterilized insoluble cutting oils used by workers who have had cutting oil dermatitis and found no significant number of staphylococci or streptococci. A large, square-end rod-like organism containing spores and some indefinite forms suggestive of yeasts and molds were found in the samples.

The insoluble cutting oils as a class are not suitable for the growth of bacteria because they contain such a large percentage of petroleum oil sulphur and chlorine and because many of them also contain an inhibitor which has antiseptic properties. Soluble petroleum oils, when diluted for use are well suited as culture

media because of the fact that they consist mostly of water and a small percentage of the soluble oil. It is possible for bacteria to grow profusely in those having a high content of fatty oils. The lard oils contain animal or vegetable oils and therefore bacteria grow more easily in them. (Lee and Chandler described a short Gram-negative rod which they found in cutting oils and which they called pseudomonas oleovorans. This organism has not been shown to be a pathogen.)

Infected follicles may develop into boils and even carbuncles and infection of wounds of the skin caused by metallic slivers may cause the development of boils or even cellulitis. Bacteriologic examination of the infected follicles or boils usually shows the ordinary pyogenic bacteria, which are found in ordinary boils and which are usually present on the skin.

The defatting action of cutting oils on the skin may cause drying cracking and fissuring. The open fissures are subject to secondary infection and its train of symptoms—boils, lymphangitis, and even septicemia. Dry skins and senile skins are most likely to be affected in this manner because the skin glands are not sufficiently active to rapidly replace the fat extracted from the skin by the mineral oils.

Metal slivers in the oils and in the waste used for drying the hands often become imbedded in the skin and may be the site of secondary infection.

Some of the mineral oils have keratogenic properties and cause the appearance of small flat brownish papillomas on the hands, arms and other parts touched by the oil or oil-soaked clothing. We have found that about 10 per cent of all workers in oils and greases have these growths. They are usually not troublesome and the worker may not be aware of their presence.

Certain mineral oils are carcinogenic but fortunately the mineral oils of North America are low in carcinogenic properties. Nevertheless a few cases of skin cancer are caused in the United States by mineral oils. Cancers caused by oils are usually of the prickle cell type. They are usually multiple and occur on the parts exposed to the oils or the oil-soaked clothing, the hands, arms, neck, and scrotum. They do not as a rule have early metastases.

Allergic eczemas are the least frequent types of cutting oil dermatitis. They are caused by hypersensitivity to the animal or vegetable oil, or inhibitor contained in the cutting oil or by allergy induced by the disinfectant which in many instances is added to cutting oils when they become rancid. We have seen cutting oils that contain as high as 5 per cent of a phenolic disinfectant which had been added from time to time during the prolonged period that the cutting oil was in the machine.

Chloracne from Cutting Oils.—Some firms make insoluble cutting oils used for extra heavy cutting operations or for use as base oils (oils used to enrich or restore used oils which have lost some of their useful properties) into which they incorporate high amounts of sulphur and chlorine. This may be accomplished by (1) treating the

oil with large amounts of sulphur chloride under heat and pressure or (2) by treating it with sulphur and adding an organic chlorine bearing chemical like the solid chloronaphthalines. In the first method chlorinated hydrocarbons are formed in the oil and in the second method they are added to the oil. When these oils are used on heavy cutting or gear grinding operations a mist of oil is seen around the machines and falls on the workers. Workers exposed to the mist of these highly chlorinated cutting oils develop chloracne

FIG. 30 — Chloracne from cutting oils containing chlorinated hydrocarbons.

lesions on the face neck, anterior surface of the body the arms the penis, scrotum and other places where the oil-soaked clothing touches the skin (Fig 30) These highly chlorinated oils give off as much as 25 per cent of their chlorine content into the air as they are subjected to the heat of the cutting operation But little of the sulphur is lost The following is an analysis of such an oil before and after using

TABLE 6

	New oil	Used oil
Viscosity at 100 F	109 00	121 00
Saponification No.	49 10	30 30
Sulphur content, per cent	0 70	0 70
Mineral acidity	Positive	Negative
Chlorine content, per cent	[illegible] 36	0 83

The oils found to cause chloracne in the various plants where studies were made had chlorine contents expressed in per cent by weight as shown in Table 7

TABLE 7

	Chlorine by weight, per cent
Oil No. 1	00
Oil No. 2	4.70
Oil No. 3	2.60
Oil No. 4	2.00
Oil No. 5	1.60
Oil No. 6	1.309
Oil No. 7	1.085
Oil No. 8	1.00
Oil No. 9	0.840
Oil No. 10	[illegible].800

No cases of chloracne were found among workers exposed to cutting oils in which the chlorine content was less than 0.1 per cent by weight. But many of these workers had the ordinary types of oil acne on the usual sites, namely, the extensor surfaces of the forearms and thighs.

Machines on which the heavily chlorinated oils are used should be vented in such a manner that the mist of oil is pulled away from the worker.

The workers should be provided with special cleansers which can dissolve or carry away from the skin the chlorinated hydrocarbons deposited on it. Sulphonated castor oil containing a synthetic detergent, as described under industrial cleansers, acts better for this purpose than soap and water.

The cysts of chloracne are best removed by incision and expression under antiseptic precautions.

Prevention.—Soluble oils, if re-used should be screened to remove metals slivers and sterilized to kill bacteria. They can be sterilized by heat or by the judicious use of disinfectants. Care should be taken that the antiseptic content should not rise so high as to act as a skin irritant.

Prevention of dermatitis from cutting oils consists chiefly in cleanliness of the person, of the clothes, of the machines, and of the oil. For personal cleanliness, workers with cutting oils should be provided with adequate washing facilities, hot and cold running water, and shower baths, and they should be compelled to use them under supervision.

Clean work clothes should be provided daily and the anterior surfaces of the body and the arms should be protected by aprons and sleeves made of impermeable material (Fig. 31), such as the new synthetic resins.

Toilet or liquid soaps should be provided for the workers and placed in convenient locations in the wash room. There should also be provided places where workers who have dry or fissured skins or acute or chronic dermatitis can wash after work with a cleanser that will not further defat or irritate the skin. Such a cleanser has been devised and consists of neutral sulphonated castor oil, to which 2 per cent of a wetting agent such as a fatty alcohol sulphate is added. The sulphonated castor oil is a good emulsifier and the wetting agent is a good detergent and works in hard or soft water. Its defatting

action is counteracted by the sulphonated castor oil If it is desired to remove dyes or stains from the skin the addition of 1 to 2 per cent of trisodium phosphate or sodium hexametaphosphate to this mixture will increase its cleansing powers and not materially increase its irritating powers. The use of kerosene gasoline or other fat solvents and strong bleaches and scouring soaps should be prohibited for skin cleansing

FIG. 21.—Protective clothing for machine operators. Dermatoses Investigations Section, Di of Industrial Hygiene United States Public Health Service.

The machines should be kept as free from old grease and dirt as possible by washing daily

The oil should be changed frequently at least once a week, and either discarded or if it is to be re-used it should be screened to remove metal filtered to remove obnoxious odors and neutralized to remove acidity Such filtration can best be done by a central system connecting with each of the machines, and recirculating

the oil or if this is not possible the oil may be removed from each individual machine and carried to the central system.* Additional antiseptics should not be added to used or rancid oils. Such a practice increases the irritating properties of the oil and is not necessary if the oil is filtered, neutralized and heat sterilized.

Clean towels should be given to the workers every day or they should have free access to clean waste. The towels should be so laundered that all slivers are removed. Waste should be discarded and not laundered because it is impossible to remove all slivers from waste.

Protective Ointments.—Since the most frequent types of occupational dermatoses caused by cutting oils are folliculitis, acne and boils, cleanliness is much more important in the prevention of dermatoses than are protective ointments. When protective ointments are used, they should be of the type that will fill the pores of the skin with an innocuous vegetable or animal fat to prevent the entrance of the mineral oil. Such an animal or vegetable fat will also act to protect the skin from the defatting action of the mineral oil because the mineral oil must first dissolve out the protective ointment before it will act on the fat of the skin. Such a protective ointment should also contain a small percentage of a wetting or emulsifying agent such as the fatty alcohol sulphates in order to make it easily removable from the skin with water. A small percentage of a harmless preservative, such as sodium perborate, is also desirable in order to prevent the fat in the ointment from becoming rancid.

Protective ointments which form films on the skin insoluble in oil are not as good as are those described above because films insoluble in oil are soluble in water and the perspiration which forms beneath them washes them off. Protective ointments which form films soluble in oil are not desirable because the cutting oil washes them off. The sulphonated oils will wash away both types of films. Films will crack when the hands and fingers are flexed and leave areas of the skin unprotected.

Workers should be prohibited from expectorating into the oil or from contaminating it in any other way.

Education.—The safety director or the physician in charge of the medical service of the plant should make it his duty to give occasional lectures to the workers as to the hazards of dermatitis from cutting oils and make them acquainted with the methods of prevention outlined above. In this educational program, the placing of placards in suitable places calling the attention of the worker to the dermatitis hazards of cutting oils and the methods of prevention has been found to be effective.

Differential Diagnosis.—Cutting oil folliculitis, acne and boil must be differentiated from folliculitis, acne, boils and furunculosis occurring from non-occupational causes. Cutting oil folliculitis, acne and boils occur on parts of the body where there is most fre-

* Individual filters and neutralizers can also be attached to each machine.

quent contact with the cutting oils or with soiled clothes. The extensor surfaces of the forearms thighs, and legs are the favored sites of cutting oil dermatitis. The condition may however occur on other parts of the body coming in contact with oil-soaked clothing Non-occupational boils usually occur on other portions of the body such as the back of the neck and the back. Occupational folliculitis and boils are usually multiple whereas non-occupational types are more apt to be a succession of solitary boils or furuncles. In occupational folliculitis and boils, evidences of oil comedones can usually be seen on the parts affected These do not occur in non-occupational types. Acne vulgaris occurs on the face and back not on the arms and thighs.

In differentiating the allergic eczematoid type of cutting oil dermatitis from eczemas of unknown origin the site of the lesions must be considered as well as the result of patch tests with the oil Allergic occupational eczemas due to cutting oil usually begin on the arms and hands or on parts of the body which have contact with oil or oil-soaked clothing Patch tests with the particular cutting oil handled by the worker should be positive if the oil is the cause Such positive patch tests should be followed by patch tests with each of the ingredients of the cutting oil to determine the actual chemical in the oil to which the worker is sensitive

Fungus infections and phytids of the hands and forearms sometimes offer a difficult problem in differential diagnosis, but here again patch testing cultures for fungi the trichophytin test in conjunction with the history site and morphology of the lesions will usually lead to a correct diagnosis.

Treatment.—Comedones folliculitis and boils caused by cutting oils can be successfully treated by cleanliness and antiseptics. Cleanliness consists in a daily change of work clothes and frequent washing of the parts affected Pus should be evacuated by surgical means and moist dressings of solutions of boric acid bichloride of mercury 1 to 1 000 or potassium permanganate 1 to 2,000 if judiciously used will usually clear up the condition.

The allergic types of cutting oil dermatitis are best handled by removing the affected worker from contact with cutting oils and then treating the dermatitis Antiseptic lotions should be used for the moist types of dermatitis and ointments for the dry chronic types. Moist dressings of boric acid Burow s solution bichloride of mercury 1 to 1,000 and the like for the acute moist types and boric acid ointment, zinc ointment Lassar s paste and coal tar preparations are suggested for the dry stages or dry eczematoid types.

For dry defatted skins an ointment consisting of a vegetable or animal fat should be given the worker to rub into his hands before and after work. The ointment suggested above as a protective may also be used for this purpose.

It is claimed that the oils containing organic chlorine compounds have some advantages over other oils in certain cutting operations.

If this is so and they must be used then heavy cutting operations where oil mist is given off should be vented in such a manner that the vapors are carried away and do not come in contact with the worker.*

Workers on such operations should be provided with clean work clothes daily and with sleeves and aprons made of a material impervious to oil. They should be provided with a protective ointment of Type 3, described in another chapter, for use on the face and neck. Showers after work should be compulsory and supervised.

The oil chemists of the plant should ascertain the ingredients of all cutting oils which are used and inform the safety director so that the workers may be adequately protected from those containing chlorine compounds.

The ordinary remedies for the treatment of acne vulgaris do but little good in chloracne. The treatment recommended is washing of the affected parts several times daily with a special industrial skin cleanser consisting of sulphonated castor oil ninety-eight parts and Duponol W. A. Pure two parts; once or twice a week a number of cysts should be evacuated by incision or expression under antiseptic conditions.

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CHAPTER XVII

OCCUPATIONAL ACNE

OCCUPATIONAL acne is one of the most frequent forms of occupational dermatitis. It occurs among workers exposed to certain chemicals which, when lodged in the pores of the skin may not only plug the openings and cause the retention of the secretions of the glands but also act as stimulants for the formation of keratin and thus lead to comedo formation and occupational acne.

Occupational acnes occur among the workers exposed to the following chemicals

Chemical	*Occupation*
Insoluble cutting oils and to some extent soluble cutting oils	Machinists
Crude petroleum	Oil-field workers, paraffin pressmen, oil refiners
Coal tar	Makers and distillers of coal tar
Heavy coal-tar distillates	Creosoting of wood roofers, road makers
Coal-tar pitch	Conduit makers, briquette makers, electrical apparatus insulators
Chlornaphthalenes	Electrical insulators
Chlordiphenyls	Electrical insulators
Chlordiphenyloxide	Electrical insulators
Solid chlorbenzols	Chemical workers
Solid chlorphenols	Chemical workers

By far the largest number of workers with occupational acne are those who are exposed to the insoluble cutting oils. This is accounted for not by the fact that the cutting oils are the most potent acne-formers, but because more workers are exposed to their actions and fewer precautions are taken to protect them The most potent of all these chemicals as far as their acne-forming properties are concerned are the chlornaphthalenes, chlordiphenyls and chlordiphenyloxides. Every worker sufficiently exposed to these three substances for a few months will develop acne-like lesions on the exposed parts unless the most stringent rules of cleanliness for clothes and body are observed However fewer workers are exposed to these chlor compounds than to any of the other acne producers. Therefore the cases of so-called chloracnes reported in the past have been relatively infrequent The acceleration of shipbuilding that has occurred since the war has increased the use of wires insulated with these chlor compounds and with this the number of so-called chloracnes.

The acne form lesions caused by the chlor compounds are more striking than those produced by the other acne-forming substances. Only from the chlor compounds has acne occurred not only in the worker but also in his immediate family and even among those who

wash his soiled work-clothes. Although the acnes caused by these organic chlor compounds have been called "chloracnes," yet chlorine gas itself causes no acne-like lesions. Neither do the inorganic compounds of chlorine cause them, either by external contact or internal administration. Nor do the acne-form lesions occur among workers with the solvent chlorinated hydrocarbons although all of the solvents can injure the skin by direct contact and can cause systemic poisoning when absorbed. Naphthalene, diphenyl, benzol or phenol without chlorination do not cause acneform lesions. Only when they are combined with chlorine do they have this effect upon the skin. While benzol and phenol alone can cause systemic poisoning, naphthalene and diphenyl have only been observed to cause it when combined with chlorine. Moreover, only the highly viscid or amorphous solid combinations of these substances have been observed to cause acneform lesions.

Solid Chlornapthalenes.—These chemicals are made by the chlorination of naphthalene, the hydrogen of the naphthalene being replaced by chlorine. Any number of the hydrogen atoms can be replaced, forming mono-, di-, etc., chlornaphthalenes. Those that cause occupational acnes begin with trichlornaphthalene and go on to higher chlorinations of naphthalenes and are used as dielectrics on condensers and insulators of wires. They may be combined with the chlordiphenyls.

Workers engaged in manufacturing the chlornaphthalenes, those engaged in coating wires or condensers with it, and those who strip wires insulated with it are the ones who have been found to be affected with acne. Some workers engaged in coating wires and condensers with it have been reported to have died of yellow atrophy of the liver.

Workers with the chlornaphthalenes usually develop acne on the face after a month or more of exposure. The covered parts of the body are also often affected because of contact with soiled work clothes. It is not at all unusual to find comedones and acne-like lesions around the umbilicus, the thighs, and in the groin.

The individual lesions may be from pinhead to pea size. They are pale, straw-colored cysts and usually do not show inflammatory changes unless they have been infected by scratching or other trauma. They usually remain stationary in size after a few months and show no tendency to involution. While secondary infections resulting in pus formation may occur, they are not nearly so frequent as in acne vulgaris.

Chlordiphenyls.—Diphenyl ($C_{12}H_{10}$) is a light yellow crystalline solid made from benzol. It is chlorinated in a manner somewhat similar to that described for naphthalene. The chlordiphenyls* are dielectrics and may be used alone or in combination with the chlornaphthalenes for this purpose. Workers who are exposed to them develop lesions similar to those described under the chlornaphthalenes.

* Known by the trade name "Arochlor."

TABLE 6.—DIFFERENTIAL DIAGNOSIS OF ACNEIFORM DERMATOSES

Acneiform lesions Due to	Age	Common Site	Clinical History	Clinical Characteristics	Histologic Features
Acne vulgaris	14–25 yrs.	Face, shoulders, back, chest	Nothing specific; no industrial exposure	Comedones, follicular papules and pustules; skin greasy and usually associated seborrhea capitis	Widely distended follicular orifice filled with keratinous material and sebaceous material; cocci in keratin plug; sebaceous glands hypertrophied; foreign body granuloma may be present
Cutting oil Soluble (rare) Insoluble Crude petroleum	Any age	Usually on exposed parts: extensors of forearms and thighs; contact with soiled clothes	Occupational exposure, such as in machinists, in oil fields and oil refineries, and paraffine pressmen	Folliculitis, pustules, furuncles, and even carbuncles; inflammation around and in acne-like lesions; comedones on fingers, back of hands, forearms and back of neck	Comedo formation but inflammatory reaction around hair follicles and in epidermis and throughout cutis is a striking feature; no cocci seen
Coal tar Heavy coal-tar distillates Coal-tar pitch	Any age	Usually on extensor surfaces of arms and thighs, where soiled work clothes touch skin	Found in makers and distillers of coal tar, in workers creosoting wood and in roofing and in road workers, workers, as conduit makers, briquette makers	Melanosis, comedones, and small yellowish cysts; not inflammatory except when scratched and infected	Melanin in epidermis and in chromatophores below it; relatively little inflammatory reaction; no cocci; widened follicular openings plugged with keratinous material; cysts filled with keratinous and some sebaceous material
Chloronaphthalenes Chlordiphenyls Chlordiphenyloxide	Any age	Face, back of ears, shoulders, abdomen around navel, groin and genitalia	Occupational exposure in manufacture of chemicals for insulating wires and condensers, electricians using heat and flame-proof wires and machinists exposed to cutting oil containing chlorinated hydrocarbons	Comedones not so prominent as straw-colored cyst; not inflammatory except when secondarily infected	Cystic lesions predominate, with absence of cocci in keratinous material filling widened follicular openings; otherwise can resemble acne vulgaris but cysts have more keratin than sebaceous material
Solid chlorbenzols Solid chlorphenols	Any age	Face, anterior surface of body	Occupational exposure in chemical workers	Comedones not prominent; cysts less prominent than from chloronaphthalenes; there may be an inflammatory allergic dermatitis	Except for allergic dermatitis, essentially that of chloronaphthalenes

wash his soiled work-clothes. Although the acnes caused by these organic chlor compounds have been called chloracnes yet chlorine gas itself causes no acne like lesions. Neither do the inorganic compounds of chlorine cause them either by external contact or internal administration. Nor do the acne form lesions occur among workers with the solvent chlorinated hydrocarbons although all of the solvents can injure the skin by direct contact and can cause systemic poisoning when absorbed Naphthalene diphenyl benzol or phenol without chlorination do not cause acneform lesions. Only when they are combined with chlorine do they have this effect upon the skin. While benzol and phenol alone can cause systemic poisoning naphthalene and diphenyl have only been observed to cause it when combined with chlorine Moreover only the highly viscid or amorphous solid combinations of these substances have been observed to cause acneform lesions.

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lesions. Otherwise the histology is like that of acne from chlorinated naphthalene compounds

Coal Tar, Coal-tar Pitch, and Heavy Coal-tar Distillates.—From the volatile substances derived from the distillation of coal there are taken off benzol, toluol, solvent naphtha, and ammonium sulphate The remaining product is subjected to fractional destillation and is divided into light, medium and heavy coal-tar oils. The residue after distillation is known as coal-tar pitch

Workers in coal-tar plants sometimes develop acneform lesions but not so frequently as do workers who handle the heavy coal-tar distillates and coal-tar pitch. This is true because the distillation process is almost totally enclosed and only a few workers come in contact with that portion of the coal tar that is active in producing acne form lesions. Melanosis and photosensitivity however occur fairly frequently among workers who break up the coal-tar pitch and among those who come in contact with heavy oils.

In manufacturing processes in which heavy coal-tar oils and coal-tar pitch are used, there is a high incidence of acneform lesions, melanosis and photosensitization. In such manufacturing processes as in conduit making where paper cylinders are impregnated with coal-tar creosote in roofing where paper impregnated with heavy coal-tar distillate is handled, and in road making where coal-tar pitch is heated the incidence of acneform lesions, photosensitivity and melanosis is high

The acneform lesions caused by coal tar and its distillate are accompanied by melanosis. The individual lesions are smaller than those caused by the chlorinated hydrocarbons but they still have the same essential characteristics. The distribution of the lesions, however is somewhat different. They usually affect the face the arms and the thighs rarely if ever are they found around the umbilicus, in the groin or other regions where acne-like lesions occur from exposure to the chlorinated hydrocarbons The keratogenous changes caused by coal tar and its distillates sometimes lead to epithelioma formation.

Histopathology of Pitch Acne—Three lesions were studied A comedo from the chest a papule on the back of the left arm surrounding a comedo, and a lesion on the left thigh which appeared clinically as an inflammatory papule In each instance the predominant lesion was a comedo with its wide follicular opening filled with keratinous material and having thickened walls. The epidermis seemed normal. No cocci could be seen in this keratinous material There was very little surrounding inflammation. The melanin formation was a striking feature It was not only found in the basal cells and in the cells above them but it was also found in chromatophores just below the epidermis. No foreign-body granuloma was seen in any of the sections. Enlarged sebaceous glands were not a striking feature

Crude Petroleum and Cutting Oils.—Crude petroleums have a varied composition depending upon their source For chemical

purposes they can be classified as follows paraffin base naphthenic base asphaltic base and mixed bases The different varieties of crude petroleum however have many substances in common—namely a mixture of hydrocarbons, nitrogen oxygen sulphur and organic and inorganic substances held in suspension or solution.

The workers employed in oil fields where the wells are free flowing are not so frequently affected by dermatoses as are those employed in fields where there is pumping This because in free-flowing wells or gushers workers have comparatively little contact with the oil whereas if the wells are pumped it is often necessary to remove the casing from the well in order to clean it and the pumps. However even among such workers acneform lesions are much less frequent than they are among workers who use specially treated mineral oils for industrial purposes

There are keratotic lesions seen on the skin of workers in oil fields located in tropical or subtropical climates. These are as likely to be due to the solar radiation as to contact with the oil

Cutting Oils.—Cutting oils are divided into two classes the soluble and the insoluble

Soluble oils usually consist of sulphonated petroleum oils highly diluted with water and are used mainly for cooling the cutting tool The oil is added for its antirust properties. Although acneform lesions occur on workers exposed to the soluble cutting oils they are nevertheless infrequent as compared to those seen among workers with the insoluble cutting oils

The insoluble cutting oils are by far the principal causes of so-called occupational acnes (and folliculitis) The oils are universally used on machine tools. Their composition varies according to the type of machinery that they are used for and according to the secret formulas of their manufacturers. However basically they usually consist of a large percentage of a more or less refined petroleum oil to which are added a comparatively small amount of animal or vegetable oil (so-called lard oil) sulphur and an inhibitor for the purpose of preventing the deterioration of the fatty oil content. To some oils a chlorine compound may be added

Most of the cutting-oil acnes occur on the extensor surfaces of the forearms and the thighs because the men work with bare arms and lean against the machines and because the anterior surface of the thighs are in contact with the oil-soaked trousers.

The lesions usually begin as a folliculitis Inflammatory reactions are the rule in contradistinction to the acneform lesions from tar and chlorinated hydrocarbon. Comedones are often present but so are pustules, furuncles and even carbuncles. It has long been thought that the inflammation was caused by pathogenic bacteria in the cutting oils, but repeated attempts to culture pyogenic organisms from these oils have failed Secondary infections of the lesions can occur but not from bacteria in the oils * Rather they occur from the bacteria on the skin or on the clothes

* Most insoluble cutting oils are sterile as far as skin pathogens are concerned.

From oils which contain solid chlorinated hydrocarbons, acneform lesions can appear which are similar to those described under the chlorinated hydrocarbons, especially if the cutting operation generates sufficient heat to vaporize the chlorinated hydrocarbon

The folliculitis caused by cutting oils is due either to the sulphur the chlorine the inhibitor or the sulphur dioxide hydrogen sulphide or other compounds generated by the heat of the cutting operation

Allergic eczemas may occur because of sensitivity to any of the ingredients in the cutting oil These manifest themselves in the form of a dermatitis and not an acne. Its occurrence is relatively infrequent The sensitivity can be demonstrated in such cases by patch testing with the oil. A folliculitis may be produced if an insoluble cutting oil is permitted to remain on the skin under a patch for many days but this is not a reaction of sensitivity

Histopathology of Oil Folliculitis (Acne) —Three sections were studied What seemed to be a typical oil folliculitis with a pustular reaction on the anterior thigh a comedo on the thigh which did not look especially inflammatory and an inflammatory papule surrounding a hair follicle on the back of the hand

1 Pustular Folliculitis from the Thigh (Three Months Duration) There was a follicular hyperkeratosis as well as a generalized hyperkeratosis and acanthosis throughout the section The mouth of the follicle was widened, and it was filled with keratinous material. The walls of the follicles were also hypertrophied. Around such follicles there was a marked inflammatory exudate consisting of leukocytes and lymphocytes. On occasions accumulations of lymphocytes and leukocytes could also be seen forming small abscesses deep in the cutis Even some of the sweat glands showed involvement by invasion of their walls with leukocytes and an inflammatory reaction consisting of edema and an accumulation of lymphocytes and leukocytes around them. The sebaceous glands did not seem to be hypertrophied. No bacteria could be found.

2. A Comedo of the Thigh The section showed a number of large follicular openings filled with keratinous material. The epidermal walls of the openings were hypertrophied. There was a marked inflammatory reaction around the hair follicles The cutis for quite a distance from the follicle showed areas of inflammatory reaction with aggregations of leukocytes and lymphocytes. The capillaries and lymphatics were dilated and were found to be engorged with white cells. Adjacent to the comedo could be seen a small epidermal vesicle filled with leukocytes. No bacteria could be found

3 Typical Oil Folliculitis on the Back of the Hands There was a widening of the follicular opening and a thickening of its walls, and the mouth of the follicle was filled with keratinous material. The surrounding epidermis showed an acanthosis and hyperkeratosis. Around the follicles and diffusely throughout the cutis there was a marked inflammatory reaction which in some instances extended to the deeper layers of the cutis. The sweat glands were not involved but there was a striking absence of sebaceous gland hypertrophy

In contradistinction to what has been seen in the changes due to pitch and the chlorinated hydrocarbons the process in oil folliculitis was much more inflammatory not only around the involved hair follicles but also in the cutis quite a distance from the follicles While there was a stimulus to keratin formation just as in other acneform lesions previously described it was more extensive and there was acanthosis of the surrounding epidermis. Pustule formation could be seen in the epidermis as well as the formation of small abscesses in the deep cutis The sweat glands were involved as part of the general inflammatory reaction No cocci were demonstrable in any of the sections. This fact plus the previous observation that the insoluble cutting oils are sterile in so far as pus-forming bacteria are concerned demonstrates that oil folliculitis is due to the chemical composition of the insoluble cutting oils and not to bacteria which they are said by some to contain

Chlorinated Cutting Oils—The lesions from the chlorinated cutting oils combine the characteristics of the lesions seen after exposure to the chlorinated hydrocarbons and those described as oil folliculitis. The histopathology also is a combination of both

Prevention.—The prevention of occupational acnes can be divided into (1) general measures and (2) personal measures

1 The manufacture of the chlorinated hydrocarbons and the coating of wires and condensers with insulating materials containing the chlorinated hydrocarbons should be done in totally enclosed processes so that the fumes of the insulating substances and of the solvents if any are used do not come in contact with the workers.

2 The workers should be provided with clean coveralls and underclothes daily These should be laundered at the plant and cleaned in such a way that no chlorinated hydrocarbons remain on them

Shower baths after work should be compulsory and supervised and there should be sufficient shower facilities provided so that the workers are not unduly delayed after work. Suitable cleansers should be provided to efficiently remove the insulators from the skin. The synthetic wetting-agents are said to be better for this purpose than ordinary soaps.

A suggested cleanser is duponol or nacconol or santomerse—2 per cent and a sulphonated oil—castor peanut, soy bean corn or linseed—98 per cent

A scrubber of corn meal may be added to this or may be available for use as needed in conjunction with it A mixture of butyl stearate and sulphonated castor oil has also been suggested

If exposure of the face and neck to fumes or contact with soiled hands is unavoidable transparent hoods covering the head and neck can be provided These can be made of cellophane pliofilm or other transparent resin film

If for any reason these cannot be had protective ointments of the invisible glove type may be used Types 2a and 2b and Type 4 as described by Schwartz, are suitable for this purpose

Periodic liver function tests should be performed every month on the workers. In addition to this monthly dermatologic examinations should be made to detect early evidence of acne.

The above protective measures should also apply to electricians and others who work with wire and condensers insulated with the chlorinated hydrocarbons.

Workers with coal tar, heavy coal-tar distillates, and coal-tar pitch should be protected against the tar fumes, if any, by exhaust ventilating apparatus. The preventive measures as to cleanliness and clothing described above also apply to these workers.

A protective application of a light screen to the face is advisable for use by those who have become photosensitized. Suggested light screens are: menthyl salicylate 10 per cent, or cycloform 10 per cent in a zinc oxide ointment base.

The prevention of cutting-oil acne consists in shielding the machines so that splashes of oil do not strike the workers and in filtering the insoluble cutting oils after one hundred and fifty hours of use. Fuller's earth or activated carbon used in the filters will improve the odor and calcium oxide will lessen the acidity. Disinfectants should not be added to insoluble cutting oil, for they only increase the skin hazard.

Personal cleanliness and protective clothing as outlined above should be encouraged. In addition to these, impervious sleeves and aprons should be provided.

Treatment.—The treatment of the occupational acnes must be governed by the stage and extent of the lesions, but in general it consists of the expression of comedones, evacuation of abscesses and cysts, and the frequent use of skin cleansers.

X-ray should be used only in special cases and with great caution because the rationale of its use in the treatment of acne vulgaris does not hold for the occupational acnes.

The personal measures of prevention described above are also measures for treatment.

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CHAPTER XVIII

DERMATITIS IN SYNTHETIC DYE MANUFACTURE

SYNTHETIC dye poisoning and dermatitis have been reported many times among the workers employed in the manufacture of synthetic dyes. Poisoning from aniline compounds called cyanosis or "blue lip" by the workers is not an infrequent occurrence among dye makers. Gehrmann has reported bladder tumors among workers who have for many years been exposed to alpha naphthylamine, beta naphthalamine and benzidine. Currie has reported systemic poisoning in which the bladder is chiefly affected among workers who purify 5-chloro-ortho-toluidine. Agol has reported dermatitis and systemic poisoning among workers with dimethyl-amido-azo-benzene. The literature contains many reports of dermatitis from handling dyed materials (see Chapter on Dermatitis from "Wearing and Handling Dyed Fabrics"). Schwartz has reported dermatitis among cable splicers caused by decomposition of dyes.

Dermatitis has also been reported from contact with dyes used to color foodstuffs. Criep reported dermatitis from contact with dyes on Easter eggs. The dyes in this case were Oil Red X 1700, a diazo dye, Oil Orange 7078, a monoazo dye, and Oil Yellow.

Traub has reported dermatitis among the handlers of dyed oranges and he attributed this dermatitis to Yellow Ortho Toluidine Beta Naphthol, as well as a combination of two dyes similar to Sudan I and Sudan II.

Certain coal-tar dyes are permitted to be used for coloring foodstuffs. The following list is taken from the Colour Index.

LIST OF DYES USED FOR COLORING FOODSTUFFS

YELLOW

Color Index N	*Commercial Name*	*Description*
10	Naphthol Yellow	Light yellow or orange yellow powder, yellow solution, officially permitted for coloring foodstuff in the U. S. and Australia.
16	Amino-azobenzene	Sparingly soluble in water with a yellow color, more so in alcohol, used for coloring fats, cheese, etc. Color index states this substance is not poisonous, but information has been received to the effect that dermatitis has been caused by it and it is carcinogenic.
[illegible]	Acid Yellow	Sodium salt of amino-azobenzene disulphonic acid, etc., used for dyeing foodstuff.
17	Amido-azotoluol	Practically insoluble in water, used for coloring fats, margarine and wax *yellow*.
[illegible]	Oil Yellow	Dimethyl-amino-azobenzene or benzene-azo-dimethylaniline known as Oil Yellow, Butter Yellow, used for coloring oils, fats, butter, margarine, etc.
22	Oil Yellow AB	Benzene-azo-b-naphthylamine, officially permitted for coloring foodstuff yellow in the United States.

List of Dyes Used for Coloring Foodstuffs—(Continued)

Color Index No.	Commercial Name	Description
23	Sudan G	This is known as Sudan G Benzene-azo-resorcinol; used for coloring spirit varnishes, oils, and fats yellow
61	Oil yellow OB	O-Toluene-azo-b-naphthylamine officially permitted in the United States for coloring foodstuffs yellow
		Orange
150	Tropaeolone 000 No. 1	Sodium salt of para sulpho-benzene-azo-dinitro-diphenylamine officially permitted for coloring foodstuffs in the United States and Australia
640	Tartrazine	Sodium salt of 4-para-sulpho-benzene-azo-1 p sulphophenyl 5 hydroxy pyrazol-3 carboxylic acid; used for coloring foodstuffs
1241	Annatto	Bixin, together with Orellin (a yellow coloring matter) etc., used only for coloring soap foodstuffs, such as butter cheese, etc.
		Red
79	Ponceau 2R	Sodium salt of meta-xylene-azo-beta-naphthol-3,6-disulphonic acid used for coloring edibles
80	Ponceau 3R	Sodium salt of cumene-azo-beta-naphthol-3,6-disulphonic acid officially permitted for coloring foodstuffs in the United States and Australia
88	Acid Bordeaux	Sodium salt of alpha-naphthalene-azo-beta naphthol-3,6-disulphonic acid used for coloring edibles
179	Carmoisine A	Sodium salt of 4-sulpho-alpha-naphthalene-azo-alpha-naphthol-4-sulphonic acid used for coloring foodstuffs
184	Amaranth	Sodium salt of 4-sulpho-alpha-naphthalene-azo-beta-naphthol-3,6-disulphonic acid officially permitted for coloring foodstuffs in Australia and the United States
185	Scarlet 6/O	Sodium salt of 4-sulpho-alpha-naphthalene-azo beta naphthol 6,8 disulphonic acid used for coloring foodstuff and also for printing wool
194	Double Brilliant Scarlet S	Used for coloring foodstuffs
677	Magenta Powder	Mixture of pararosaniline (No. 676) and rosaniline hydrochlorides used for coloring foodstuffs Rosaniline is officially permitted for coloring foodstuffs in Australia. Roseine is another name for this dye
752	Rhodyle 6G 6G Conc	Ethyl ester of diethyldiamino 0 carboxy phenyl-xanthenyl chloride used for coloring foodstuffs
773	Erythrosine	Sodium or potassium salt of tetraiodo-fluorescein officially permitted for coloring foodstuffs in Australia and the United States
		Brown
331	Bismarck Brown C	Hydrochloride of benzene-meta-diazobis-m-phenylene diamine; used for coloring foodstuffs and is officially permitted for this purpose in Australia

List of Dyes Used for Coloring Foodstuffs—(*Continued*)

Color Index No	Commercial Name	Description
		Green
666	Acid Green G	Sodium salt of dibenzyldiethyldiamino-triphenylcarbinol disulphonic acid anhydrid appearance dull dark green powder; used for coloring foodstuff
670	Fast Acid Green	Light green SF yellowish, is officially permitted for coloring foodstuffs in Australia and the United States
		Blue
865	Nigrosine water-soluble	Used mainly for dyeing silk, but is also used for coloring foodstuff
1180	Indigo Extract L paste	Sodium salt of indigotin-5 5-disulphonic acid officially permitted for coloring foodstuff in Australia and the United States
		Black
865	Nigrosine Black	Appearance, glistening black lumps; used for coloring foodstuffs

By far the larger percentage of dyes used are harmless only the rare sensitive individuals being affected by them Indeed aniline dyes are used in treatment of skin diseases. Brilliant green malachite green gentian violet, methyl violet acri-violet, safranin magdala red and toluidine blue are examples of dyes used in solution in the treatment of skin diseases

The authors personal observations were based on the examinations of five dye manufacturing plants employing a total of about 3,800 men. The medical records of these plants showed a total of 4 777 cases of accidents and illnesses treated in the plant dispensaries. Of this number 15 per cent were skin cases more than one-half of these were due to acid and caustic burns and the remainder (over 40 per cent) were cases of dermatitis About 50 per cent of all the skin cases occurred in the maintenance and repair departments. The men working in these departments repaired pipes vats and tanks and came in contact with all the chemicals used in the plant

An analysis of 400 cases of dermatitis which occurred in the plants mentioned above showed the causes to be as follows

Acid burns	Safranine	Soda ash
Alkali burns	Erio black	Phenylglycine
Sodium burns	Guanidine	Nitro benzol
Dinitrochlorbenzol	Benzanthrone	Naphthalene
Bismarck brown	Benzidine	Paramino phenol
Bleach	Diphenyl	Alpha naphthylamine
Azo colors	Beta naphthol	
Hot lead	Crystal violet	

In about 25 per cent of the cases, the irritating chemical was not determined Most of these cases occurred in the summer months

and it was recognized by the workers that heat and perspiration added to the irritating action of these chemicals.

In addition to the dermatitis, there were noted 72 cases of conjunctivitis caused by the following chemicals

TABLE 9

Chemical	No. cases	Chemical	No. cases
Hydrogen sulphide	25	Ammonia	2
Auramine	3	Sodium hydrosulphite	1
Crystal violet	3	Formaldehyde	1
Dinitrochlorbenzol	3	Para-nitro-toluol sulphonate	1
Safranine	3	Victoria green	1
Victoria blue	2	Anthracene silver salt	1
Sodium sulphide	2	Lime	1
Benzol	2	Aniline	1
Benzanthrone	2	Alpha naphthylamin acid	1
Methyl violet	2	Caustic dust	1
Camphene	2	Black X dye (azo)	1

Unknown chemicals, 11 cases

Synthetic dyes are prepared from the coal-tar derivatives such as anthracene naphthalene fluorene and benzol etc. They are subjected to the action of nitric and sulphuric acid in processes called nitration and sulphonation and the resulting compounds are again acted on by other chemicals until the final product is obtained. The compounds developed before the final products are known as intermediates.

The reactions take place in kettles vats, and autoclaves and the intermediates and the finished dyes are separated by filtering through filter presses, gravity filters, suction filters or mechanical filters. They are then dried by heat, vacuum or both in various forms of driers, then ground or flaked The pure dye is usually mixed with a diluent (salt or dextrine) or made into a paste with molasses. This is done in order to standardize the color

The dyes are variously classified according to composition or derivation. One classification taken from the Colour Index, Society of Dyers and Colourists is as follows

1. Nitroso coloring matters
2. Nitro coloring matters
3. Mono-azo coloring matters
4. Dis-azo coloring matters
5. Tris-azo coloring matters
6. Tetrakis-azo coloring matters
7. Stilbene coloring matters
8. Pyrazolone coloring matters
9. Ketonimine coloring matters
10. Triphenylmethane and diphenylnaphthylmethane coloring matter
11. Xanthene coloring matters
12. Acridine coloring matters
13. Quinoline coloring matters
14. Thiazole coloring matters
15. Indamine coloring matters
16. Indophenol coloring matters
17. Azine coloring matters
18. Aniline black and allied coloring matters

LIST OF DYES USED FOR COLORING FOODSTUFFS—(*Continued*)

GREEN

Color Index No.	*Commercial Name*	*Description*
666	Acid Green, G	Sodium salt of dibenzyldiethyldiamino-triphenylcarbinol disulphonic acid anhydride appearance dull dark green powder; used for coloring foodstuffs
670	Fast Acid Green	Light green SF yellowish is officially permitted for coloring foodstuff in Australia and the United States

BLUE

863	Nigrosine water-soluble	Used mainly for dyeing silk but is also used for coloring foodstuff
1180	Indigo Extract L past	Sodium salt of indigotin-5 5-disulphonic acid officially permitted for coloring foodstuff in Australia and the United States

BLACK

865	Nigrosine Black	Appearance glistening black lumps used for coloring foodstuffs

By far the larger percentage of dyes used are harmless only the rare sensitive individuals being affected by them. Indeed aniline dyes are used in treatment of skin diseases. Brilliant green malachite green gentian violet methyl violet acri-violet, safranin magdala red and toluidine blue are examples of dyes used in solution in the treatment of skin diseases.

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Hot lead	Crystal violet	

In about 25 per cent of the cases the irritating chemical was not determined Most of these cases occurred in the summer months

brunettes or colored men are employed in the grinding and mixing operations because it has been found that they are less liable to dermatitis than are blondes.

Men who work on flaking machines also come in contact with irritating chemicals.

The repair or maintenance department in dye manufacturing plants usually comprises about one-third of the entire force but the incidence of dermatitis in this department is about 50 per cent of all the cases occurring in the plant. When repairs are to be made the men must enter kettles vats, and retorts which contain irritating materials with which the operator does not usually come in contact. When underground pipes are to be repaired it is necessary to dig up the ground which has been soaked with the irritating chemical which has leaked from the damaged pipe.

Newly employed men are more likely to develop dermatitis, either because they are less aware of the dangers than are the older employees or because they are less immune Some of the new men who develop a mild dermatitis keep on working and finally become "hardened" as the workers call it Others who develop a severe attack which necessitates a lay-off from work do not as a rule develop that immunity and must be taken off the job or even removed from the plant. Sometimes workers who had been in the plant for many years develop a dermatitis from the materials which they handle. Such men have become sensitized to these materials and rarely ever again become immune. More often they become sensitive to more and more substances. Sometimes a worker who has been in the plant for many years will be moved to a new process and develop a dermatitis from contact with the new chemicals.

Fig. 33 – Dermatitis on the forearms of filter press cleaner in the manufacture of aniline dyes, due to a naphthalene intermediate

The dermatitis does not usually develop immediately after contact with the offending chemical. A period of time varying from a few hours to a few days elapses before the dermatitis begins, and

for this reason the worker often cannot tell which chemical is the cause of the dermatitis. Sometimes weeks may pass between the beginning of work and the onset of the dermatitis. This may be due to the cumulative effect of continued irritation or to a period of sensitization. Many of the intermediates used in dye manufacture are known to be sensitizers.

Chemists who work in the laboratories often contract dermatitis from compounds not ordinarily used in the plant. Many chemists know that they are hypersensitive to certain chemicals and there are a few who are sensitive to many chemicals. Some are so sensitive that merely entering a building which contains the irritating chemical is sufficient to cause erythema of the face. This is especially true of hypersensitivity to dinitrochlorbenzol.

Practically all nitro and nitroso compounds are skin irritants or sensitizers to a considerable percentage of people but almost any of the chemicals used in dye manufacture may cause dermatitis among hypersensitive individuals (Fig. 32). The following is a list of intermediates found by the authors to have caused dermatitis.

Acids, sulphonic
Anthraquinone, chlorinated
Anthracene (silver salt)
Alpha naphthylamic acid
Amino-azo-benzol
Benzidine
Benzanthrone
Beta methylamino anthraquinone
Bismarck brown
Beta oxy-naphthoic acid
Benzoyl para amino phenol
Beta hydroxy naphthoic acid aniline
Benzoyl benzoic acid
Brom-benzanthrone
Beta naphthol
Cresol
Chlor benzol
Chlor aniline (para and ortho)
Dinitro benzol
Dinitro phenol
Dinitro anisol
Dehydro thio meta xylidine
Dichlor aniline
Dinitro toluene
Dinitrochlor benzene
Formic acid
Guanidine
Hexanitrodiphenylamine
Indo-phenol
Iso-rosinduline
Mischler's hydrol
Meta toluene diamine
Methyl anthraquinone (chlor and beta)
Nitraniline (para and beta)
Naphthylamine (alpha and beta)
Nitro benzene
Nitro dimethylaniline
Naphthalene
Nitro benzanthrone
Nitroso di ethyl aniline
Nitro beta methyl anthraquinone
Orange R thiazole
Ortho nitro toluol
Ortho nitro chlor benzol
Ortho amino phenol
Phenyl hydrazine
Phenyl hydrazine para sulphonic acid
Phthalic anhydride
Phenyl glycine, an intermediate in the making of indigo
Para tolyl nitrile
Para nitroso-phenyl
Para nitro benzoyl chloride
Para nitro ortho amino phenol
Para nitro chlor benzene
Para nitro toluene
Polysulphide
Para amino phenol (fur dye and photo developer)
Resorcinol
Sodamid used in making indigo
Toluene
Toluidine

Although dye manufacturing plants which specialize in various products have different chemicals as the chief causes of dermatitis the opinion is unanimous that, outside of acid and alkali burns dinitrochlorbenzol is the most troublesome skin irritant (Fig. 33). It is used in the making of sulphur blacks is soluble in fats, and in

the pure state or in strong solution will irritate any skin. Wedrow states that as little as 0.001 mg per liter of air in the work room will irritate the skin. A 0.5 per cent solution in alcohol used as a patch test for twenty-four hours causes a marked reaction among sensitive workers. However some claim to be immune to its action. It causes a vesicular eruption which goes on to desquamation. Removal from contact usually results in a cure in one or two weeks.

FIG. 32.—Dermatitis of the arm occurring in a maker of sulphur dyes due to contact with dinitro-chlorbenzene.

A worker who claimed that he was not affected by it was patch tested with a 5 per cent alcoholic solution and after twenty-four hours he had an inflamed ulcerated area under the patch test.

Nitroso dimethyl aniline, an intermediate used in making basic colors, is also a powerful irritant. Metallic sodium and sodamid which are used in the manufacture of synthetic indigo often cause accidental burns. Various sulphonic acids contain sufficient sulphuric acid to cause dermatitis. Alpha naphthylamine benzidine, benzanthrone and anthraquinone are also frequent causes of dermatitis, although they do not irritate all the workers.

By far the largest number of finished dyes are innocuous, althought in the authors' experience the following have caused dermatitis:

Amido-azo-benzene	Paraphenylene diamine
Amido-azo-toluene hydrochloride	Pyrogene violet brown (a sulphur dye)
Aniline black	Orange Y
Bismarck brown	Orange R.
Brom acid (brom fluorescein) (light sensitizer)	Hydron blue
Erio black	Indanthrene violet R.
Brillant indigo 4G	Indanthrene violet R.R
Black X dye	Indanthrene dark blue R
Crystal violet	Ionamine A. S
Chrysoidine R	Safranine
Rubiazol (sulphamido-chrysoidine)	Sulphanthrene pink F. F
Meta phenylene diamine	Thio-flavine
Methyl violet	Victoria blue
Metanil yellow	Victoria green

Other dyes reported to have caused dermatitis are

Alizarine	Marine blue
Anthracene colors	Malachite green
Acridine	Manchester yellow
Acridine red	Martius yellow
Anthraquinone	Naphthol yellow
Aniline pencils (cause aseptic necrosis)	New blue R
Auramine	Orange II
Aurantia	Para red
Aniline yellow	Phloxin
Benzidine colors	Picric acid
Brilliant green	Primuline
Butter green	Resorcin green
Crystal green	Safranine
Dimethyl amido-azo-benzene	Spirit blue
Diphenyl black base	Triphenylrosanilin
Eosine } Photosensitizers	True yellow
Erythrosine } Photosensitizers	Vesuvine
Fuchsine	Victoria yellow
Hexanitrodiphenylamine	Water blue

The following dyes and intermediates have been reported to have caused *systemic poisoning*

Hexa nitrodiphenylamine (pain and lymphangitis)	
Methyl violet (pain and malaise)	
Aniline black	Cyanosis, nausea, headache and vertigo
Nigrosine	
Chrysoidine	
Mononitrophenol	Death
Dinitrophenol	
Nitrochlorbenzene	
Chlorhydrate of aniline	
Fuchsine	Methemoglobin
Malachite green	
Triphenylmethane	Papillomata and epitheliomata
Alpha naphthylamine	
Benzidine	
Scarlet red	
Brilliant red	

Diagnosis.—Workers in dye plants usually attribute skin irritation to the chemicals they handle. Dermatophytosis, rhus poisoning, urticaria, psoriasis and even scabies have been claimed by them to be due to the chemicals with which they work. From the diagnostic point of view fungus infection and its allergic reactions are most often confused with chemical contact dermatitis.

The patch test should be used in all cases of doubtful diagnosis. The patient should be patched with the chemicals he handles unless it is known that he has handled a general irritant without proper protection, in which case the cause is more or less obvious. General irritants should not be used for patch tests. Only such dilution of them should be used as have been found by experiment not to irritate the normal skin when left on for twenty-four hours. Materials which fellow workers handle in pure form without developing

dermatitis may be used in pure form. The patches should be applied on a clear portion of the skin and allowed to remain on for twenty-four hours. Sometimes it is necessary to leave the patch on for a longer period, even four or five days, before a reaction occurs. In case of a negative reaction it must be borne in mind that reactions may develop at the site of the patch three or four days after the patch has been removed. These are known as delayed reactions.

Chemical dermatitis in the acute stage is usually an erythematous, edematous, vesicular rash occurring on the exposed parts. It usually occurs among new workers and there is an interval varying from a few hours to a few days or weeks between contact with the offending material and the appearance of the eruption.

When there is exposure to dust as in the case of the grinders and mixers, the covered parts may become affected because the dust penetrates the clothing. In such cases the belt line, ankles, and other areas of friction become affected. The face and the back of the neck are favorite sites for dermatitis where there is exposure to dusts.

Irritating vapors affect the face and eyes; liquids and solids usually affect the dorsum of the hands and the inner surfaces of the forearms.

Mild cases of dermatitis may simply consist of erythema, a few papules, and slight desquamation.

Chronic cases of chemical dermatitis resemble chronic eczemas due to any cause, and it is difficult to discover the offending chemical even by patch tests because it is not unusual to find these workers sensitive to many substances.

The following materials have been applied for twenty-four hours to normal skins without causing a reaction, although they have caused a reaction among hypersensitive individuals:

Dinitrochlor benzol	0.5% alcoholic sol.
Amino-azo-toluene	2% alcoholic sol.
Di-ortho-tolyl-guanidine	Pure powder
Di-ortho-tolyl-thiourea	Pure powder
Mono-benzyl-para-amino phenol	Pure
Meta-toluylene-diamine	Pure
Michler's hydrol	5% alcoholic sol.
Naphthylamine	2% alcoholic sol.
Nitroso-di-ethyl-aniline	1% alcoholic sol.
Phenyl-alpha-naphthylamine	Pure
Pontamine black	Solid powder
Para-nitro-benzoic acid	Pure
Phenyl-glycine	Pure
Tetra-methyl-thiuram-mono-sulphide	Pure
Tetra-methyl-thiuram-di-sulphide	Pure

Any of the finished dyes may be placed on the skin in pure form and left on for twenty-four hours without irritating the normal skin.

Aniline and many of the intermediates used in dye manufacture when taken into the system either through the lungs or through the

mouth cause cyanosis or "blue lip" and treatment rooms for this condition are maintained in all of the plants.

An excessive amount of papillomata and carcinoma of the bladder has been noted among workers with synthetic dyes. Various substances such as aniline, benzidine, toluene, dinitro phenol, beta naphthylamine, etc. have been blamed as causative agents. In one plant where it is thought that dinitro phenol is the cause of papilloma of the bladder, the men are examined every six months for dinitro phenol in the urine. If found to be present, they are removed from contact with the materials.

PREVENTION OF DERMATITIS IN SYNTHETIC DYE MANUFACTURE

Of prime importance in the prevention of dermatitis is the selection of workers. New applicants for positions should be stripped and examined for skin diseases. No one should be employed who shows any signs of eczema or who gives a history of plant dermatitis of any kind. Those who give a history of having had urticaria, hay fever, or asthma should also be rejected, since such persons are likely to have sensitive skins.

Chemicals known to be skin irritants should only be handled by workers known to be immune to their action and workers who have acquired a hypersensitivity to any of the materials with which they work should be removed from contact with those materials.

The ideal to be attained in the prevention of dermatitis is to keep the irritating materials from coming in contact with the workers. In order to accomplish this, totally enclosed processes should be installed whenever old apparatus wears out, or when new plants are erected. The use of modern machinery, such as rotary vacuum filters discharging into continuous drum driers which in turn discharge into totally enclosed grinders and empty through enclosed pipes into barrels, prevents contact with irritating chemicals. Kettles, vats and autoclaves should be so constructed that, when opened for inspection or loading, a suction exhaust system automatically begins to operate and draw dust or fumes away from the opening.

Suction filters should be used where rotary vacuum filters are impractical, and open filter presses should only be used for processes where other types of filters are unsuitable. Modern vacuum steam driers should replace old-fashioned stove driers in processes where continuous drum driers cannot be used. Before the pans from these driers are emptied, they should first be placed in a closed box connected with exhaust ventilation so that dust does not arise. Filtered material should be kept in a moist state wherever possible, since in this state dust will not arise and permeate the workers' clothing, thus causing dermatitis.

The allaying of dust by systems of exhaust ventilation in the building and by performing dusty operations in an enclosed space

and under ventilating hoods will help to prevent dermatitis. The floors should be vacuum-cleaned and not swept. Raw materials should be unloaded from enclosed barrels by suction methods.

The workers should be supplied with clean underclothing and work clothes every day and they should be compelled to take shower baths after the day's work. When gloves are used they should be worn with the sleeve of the shirt extending over the glove to prevent the entrance of dust or liquids. Where dust cannot be allayed or where there are irritating fumes which cannot be kept away from the worker protective ointments on the exposed parts have helped to prevent dermatitis. Although there are many such preparations on the market, ordinary cold cream lard lanolin or vaseline sometimes answer the purpose

Goggles and respirators are often used to protect the eyes and lungs from irritating dusts and fumes The chafing of the skin of the face at the point of contact with the goggles or the respirators to which the workers object may be prevented by means of a mild ointment applied at these points.

Workers often use strong soaps and bleaches to remove dirt and dye from their hands Their use should be prohibited because they are often the cause of dermatitis. The management should supply non-irritating soaps or chemicals for this purpose.

To remove dyes from the hands they should first be washed with a sulphonated oil followed by water Then wash the hands in a 1 to 2,000 solution of potassium permanganate this to be followed by washing them in a 2 per cent solution of sodium hydrosulphite or a 2 per cent solution of sodium bisulphite, followed by washing again in water To avoid irritation of the skin which may result from the frequent use of these chemicals, it is well to rub into the hands at night an emollient cream the chief ingredient of which should be lanolin.

In some plants only colored workers are employed for such occupations as cleaning filter presses or grinding and mixing colors because it is thought that they are less liable to dermatitis than are white men.

The education of the workers concerning the health hazards to which they are exposed by frequent talks on safety the rigid enforcement of safety rules, and discharge as the penalty for violations help to keep down the incidence of dermatitis.

The medical staff should make periodic examinations of all workers to discover unreported cases of dermatitis.

Mild cases may continue work while using some protection for the exposed parts, such as long sleeves and gloves and a protective ointment Workers treated in this manner recover and become hardened or immune The immunity is present while the man continues to work but may last only a short time a week or two, after work is discontinued If for any reason the worker is away from his job for a week or two he develops dermatitis upon resuming work.

Workers with severe dermatitis should be taken off the job and treated with a mild lotion such as calamine or boric acid. When they recover they should be placed in another part of the plant where they will not come in contact with the offending chemical.

The treatment and disposition of chronic cases is a puzzling problem. *If they must be retained in the factory they should be* given positions where they are removed from all contact with chemicals. Desensitization has not met with any marked success.

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CHAPTER XIX

DERMATOSES DUE TO FABRIC DYEING

SILK

SILK dyeing establishments must be kept particularly clean to prevent spotting of the materials. *Silk can be dyed either in the hank or in the finished piece.* When dyed in the hank, a number of hanks are bound together placed into the dye bath on smooth wooden pins, and worked by hand. The hanks are turned so that they are evenly dyed. The dyer must handle the wet dyed silk and often wrings out excess dye and smooths and stretches the hanks. His hands are stained with the dye and if he is sensitive to anything in the dye bath, dermatitis may develop.

In piece dyeing the fabrics are first put through a singeing machine to burn off the fuzz. Following this the material is further smoothed by steaming. Then it goes through the boiling off room where it is boiled in a solution of soap and caustic in order to remove the grease and gum which it may contain. Some of the material may require bleaching and this is done by passing it through vats containing various strengths of chlorine or hydrogen peroxide and sodium silicate. The goods are further washed in a solution of sodium carbonate rinsed in water then immersed in dilute hydrochloric acid washed with water and finally dried in centrifugal drying machines. In these preparatory operations the workers are exposed to acids, alkalis, and bleaching solutions. Burns occur from acids and alkalis and dermatitis from the bleaching solutions (Fig. 34).

Chapping of the hands is of frequent occurrence especially among women employed in the preliminary treatment of the silk, and is due to the solutions of alkalis and soaps.

If the silk is to be weighted it is done after the operations described above. To weight silk, it is first divided into lots called passes, weighing about 150 pounds and just sufficient to fill a *centrifugal weighting machine.* The passes are immersed in an acid solution of tin tetrachloride and allowed to stand for about one-half hour. The liquid is then drained off and the goods are dried by centrifugation in the same machine. They are then sprayed with water to precipitate the tin in the fiber of the goods and they are then immersed in water baths to remove the excess of the weighting material. After removal from the water they are then again centrifuged and then immersed in a bath of hot disodium phosphate to form tin phosphate in the material. They are again washed in water put into a bath of weak hydrochloric acid solution again washed in water and centrifuged. These operations are repeated until the goods are of the required weight.

Lead acetate and disodium phosphate may be used for weighting instead of tin tetrachloride. This weights the silk with lead phosphate. Barium chloride and sulphuric acid or sodium phosphate may be used to weight the silk with barium sulphate or phosphate. The silk can be weighted by soaking in a solution of titanium chloride or titanium sulphate and then treated with ammonia and exposed to the air. This weights the silk with titanium oxide. After the weighting process, the goods may then be passed through a weak solution of sodium silicate, washed in water and dried. They are then ready to be dyed. The workers who weight silk wear high rubber boots, long aprons and long rubber gloves to protect them from the irritating weighting solutions, but despite these precautions acid burns and dermatitis occasionally occur.

Fig. 34.—Dermatitis of inner surface of wrist and forearm due to bleaching solution containing chlorine. Sho positive patch test.

In a silk dyeing plant employing about [illegible] 000 workers, 50 cases of dermatitis were seen during a period of two years. Only 10 among those seen could be proved by patch tests to be due to the mixture of dyes and chemicals in the dyeing vats. None was due to the dye alone. Twenty-seven of the cases were due to the solutions used to clean the dyes from the hands of the workers and 7 were due to the action of acids and alkalis.

Chemicals Used in Dyeing Silk.—Sulphuric acid is used in soap baths to liven colors. Sulphurous acid is used to bleach silk. Hydrochloric acid and nitric acid are principally used to make stannic

chloride. Acetic acid is used in the dye bath especially for black dyes. Formic acid is also used in the dye bath. Oxalic acid is sometimes used in chrome baths to mordant silk. Tartaric and citric acids are used in conjunction with basic and eosine dyes. Tannic acid serves as a loading material for silk and as a mordant. Ammonia is used as a washing and bleaching agent and in conjunction with chrome mordants. Sodium peroxide is used as a bleaching agent.

Salts of ammonium potassium sodium calcium and magnesium are also used for various purposes in different dye baths

Aluminum iron and chromium salts are chiefly used for mordanting Tin is used for loading silk zinc hydrosulphite for stripping colors copper salts for logwood and aniline black dyeing potassium antimony tartrate for fixing tannin on the fiber and vanadium in aniline black dyeing

Soaps made from olive oil oleic acid, and castor oil are used in the silk dyeing industry Bast soap is a solution of sericin in an olive oil soap. Turkey red oils extensively used in the dyeing industry are sulphonated castor oils made by heating 100 parts of castor oil with 20 parts concentrated sulphuric acid washing the product first with water then with a solution of sodium sulphate Sodium hydrate or ammonia is then added until it gives a clear solution with water Rancid olive oil is sometimes used instead of castor oil They are used not for washing and scouring as are the true soaps, but merely for wetting purposes.

For the purpose of dyeing, dyes are classified differently than from the manufacturing standpoint.

Direct or substantive dyes are taken up directly from their solutions by the fiber Most of these dyes are taken up by both animal and vegetable fibers, although some will dye animal fibers better than vegetable fibers. They "bleed" readily from vegetable fibers. Examples of dyeing instructions from direct dyes are as follows

The dye bath should contain the necessary amount of dye and salt equal to 10 to 20 per cent of the weight of the material to be dyed. The material is entered at 140° F the bath brought to a boil and boiled for one-half to three-quarters of an hour The heat is then shut off and the goods worked in a cooling bath for one-quarter hour longer The material is lifted rinsed and finished Some direct dyes require sodium phosphate Glauber's salt, or acetic acid in the dye bath in addition to the salt.

Sulphur colors are obtained by fusing sodium sulphide with various organic substances. They are used to obtain fast shades on cotton or other vegetable fibers. They are insoluble in water and are dyed from a solution in sodium sulphide Many of them are reduced by the bath and are presented to the fiber as more or less colorless compounds which are afterward oxidized by contact with the air (aging) Sulphur colors have fastness to light and washing and do not bleed like direct cotton colors. An example of dyeing directions for sulphur colors is as follows

Mix color with twice its weight of sodium sulphide concentrated by boiling in water When dissolved the color is added to the dye tub in which salt equal to 20 to 30 per cent of the weight of the material to be dyed is added The material is entered at 180° to 200° F and worked at this temperature for one hour It is then lifted oxidized rinsed dried and finished

Acid dyestuffs comprise all those which are of an acid nature They are either nitro compounds or sulphonic acids. Some of these colors belong to the class of direct cotton dyes while others may be used in conjunction with mordants. Although as a rule they will only stain cotton lightly and the shades are fugitive they are of great importance in wool dyeing (The wool is dyed at boiling temperature with the addition of sulphuric acid. It forms lanugic acid with the wool and this is the substance primarily dyed)

Acid dyes are also used considerably for dyeing silks. An example of dyeing directions for acid dyes is as follows

The required amount of color is dissolved and added to the dye bath together with Glauber s salt amounting to 10 to 20 per cent by weight of the weight of the wool to be dyed and 2 to 4 per cent of sulphuric acid The material is entered at 100° F the bath gradually brought to a boil and dyeing continued for one hour The goods are lifted rinsed and finished

Silk is dyed in a boil-off' liquor or Glauber s salt bath to which acetic acid is added and exhausted if necessary with sulphuric acid

Basic dyes consist of colored salts of colorless acids and organic color bases Animal fibers dyed with these dyes take up only the colored basic ion leaving the acid behind in the bath Cotton is nearly always dyed by basic dyes with the intervention of an acid mordant On account of their brilliance the basic dyes are extensively used to dye silk, despite their fugitiveness. An example of instructions for basic dyes is as follows

The requisite amount of dye is dissolved in hot water and added to the dye bath with acetic acid in from 3 to 4 per cent of the weight of the material to be dyed The mordanted material is entered cold and the dye bath brought to 140° to 160° F for one-half hour

Glauber s salt and alum bath or a small amount of sulphuric acid instead of alum are best used in the dye bath for wool and silk dyeing

Mordant dyes are basic or acid substances which are not fixed on the fiber directly but are caused to combine with a compound of acid or basic nature called a mordant which has usually been previously deposited on the fiber The compound formed is termed a color lake Some dyes, such as alizarin or logwood yield different shades with different mordants and are called polygenetic dyes.

Vat dyes are insoluble dyes brought into solution in an alkaline liquid containing a reducing agent. The material to be dyed is impregnated with the leuco-compound formed and then exposed to the air the dye being thus produced They are very fast dyes. Indigo is the most important vat dye. Others are the thioindigo

ciba, idanthrene duranthrene and alizanthrene colors An example of instructions for vat dyeing is as follows

The proper quantity of caustic soda is dissolved in water equal in volume to about ten times the amount of dyestuff to be used The color properly pasted with water is added preferably through a sieve the temperature brought to 110° to 120° F and concentrated hydrosulphite stirred in. The reduction should be complete in fifteen to twenty minutes.

The dye bath is prepared with the necessary water at 75° to 80° F and sharpened with 4 ounces each of caustic soda and hydrosulphite.

The stock vat is run in and the yarn is then entered and worked steadily cold for ten or fifteen minutes after which it is given about one turn every five minutes for forty-five minutes longer Glauber's salt is added about fifteen minutes after the yarn The goods are then lifted squeezed oxidized washed thoroughly acidified in a bath containing 1 pint of sulphuric acid for each 100 gallons of water washed again and then soaped at the boil for one-half hour A very thorough soaping is essential to obtain the maximum fastness and true shade. The material is then washed dried and finished

Dyes Produced by Chemical Means in the Fiber —Aniline black is produced by exposing the fiber in a bath containing aniline salt bichromate and hydrochloric acid then drying and aging in a warm moist atmosphere to develop the color Potassium ferricyanide or sodium chlorate may also be used as oxidizers.

Ice colors belong to a class of insoluble azo dyes and are produced on the fiber They are employed in cotton dyeing In dyeing the cotton is impregnated with an alkaline solution of B-naphthol caustic soda and some Turkey red oil (sulphonated castor oil) It is then dried and cooled The developing is done in a solution of diazotized base various substances producing different shades. Paranitraniline chlor-anisidine and alpha-naphthylamine are used and the diazotized solution is made neutral or feebly alkaline by the addition of caustic soda or sodium acetate.

An example of instructions for dyeing with a developed color is as follows

Pontamine diazo black BHSW concentrated is dyed like other direct colors using 15 to 25 pounds of common salt per 100 pounds of material and boiling for one-half to three-quarters of an hour with a subsequent cooling of one-quarter hour The material is thoroughly rinsed and entered into a cold diazotization bath For this purpose 1½ to 3 pounds of sodium nitrite and 3 to 5 pounds of sulphuric acid 66° B (or 5 to 7½ pounds of hydrochloric acid 21° B) are used the bath being cooled with ice if necessary The goods should remain in this bath for one-quarter hour being continually worked during this time after which they are thoroughly rinsed The material is then run into the developing bath which contains 1 pound of pontamine developer TN previously dissolved in water with 1 pound of soda ash. This bath is also kept cold and

after working for fifteen minutes the material is again thoroughly rinsed

These directions are copied from the dyeing directions issued by the DuPont de Nemours and Company Inc.

Mineral colors are used to a slight extent for cotton dyeing They are produced on the fiber as insoluble pigments from substances which are not dyes Chrome yellow and chrome orange manganese brown mineral khaki and Prussian blue are examples

Natural dyestuffs are still used to a small extent in the dyeing of fabrics

1 Natural indigo for dyeing blue.

2 Logwood is used for dyeing blue, violet or black with various metallic salts such as aluminum copper iron and chromium It contains hematoxylin which when oxidized is converted into the coloring matter hematein.

3 Redwood or Brazil wood for dyeing red

4 Rustic or yellow wood for dyeing yellow

5 Quercitron the powdered bark of *Quercus tinctoria* for dyeing yellow

6 Turmeric, the powdered root of *curcuma longa*, for dyeing yellow

7 Weld obtained from *Reseda luteola*, dyes silk a fast yellow with aluminum mordant.

8. Cutch, obtained from the acacia of India is used for gray black, and olive shades.

The chemicals and dyes are stored in the color room and are weighed and issued by special workers in this room These workers occasionally suffer from dermatitis and nasal mucitis from the dust of such irritating chemicals as chromates when the chemicals are issued

The solid dyes and the dye pastes are prepared for use in the color kitchen by mixing them with the various chemicals such as acids Turkey red oil soaps salts gums etc. Dermatitis sometimes occurs among workers in the color kitchen from these chemicals The dyers obtain the colors from the color kitchen and they do the actual preparing of the dye baths. After the dye vats are prepared the piece goods are entered and are moved through the dye liquor on revolving wheels called Becks or over rollers called jiggers The men working in the dye house wear rubber boots or shoes with heavy wooden soles because the floors are wet. They are also equipped with rubber aprons and gloves Dermatitis due to the dye liquors is of infrequent occurrence

After the material has been dyed it is dried centrifugally and put in the drying room Here it is unfolded and passed through large drying machines examined for dyeing flaws and rolled The rolls are taken to the finishing room and the material is passed through machines which stretch and widen it (stentering machines ') From here it is sometimes passed through another machine to soften it (button breaker ') and then sent to the folding room

During the course of these operations which involve repeated rolling and unrolling of the silk, the workers who hold the material as it passes over the rollers have the skin of the fingers rubbed thin and as a result they often become tender and sore. The skin of the finger-tips is smooth red and the natural lines obliterated or very faint.

Steam burns from the hot coils of the drying machines and the stentering frames also occasionally occur

Some of the dyed material goes to the print shop where designs are printed on it. The engraved copper rollers for the printing machines are made in the photoengraving department of the factory A separate engraved roll is made for each color to be printed the rolls are assembled in one machine and all the colors put on in one machine A printing machine has revolving in it as many rollers as there are colors in the design and each roller places its color in exactly the proper place. After the material has passed through the print machine, it is put into aging boxes where it is subjected to the action of steam which discharges the ground color and develops the desired color It is then washed in soap and water hydro-extracted and goes to the finishing room.

The workers in the engraving department sometimes suffer burns from the acids used Dermatitis also occurs from washing the hands in strong solutions of turpentine or petroleum distillate to remove dirt.

The men who clean the rolls and printing machinery suffer at times from dermatitis caused by the cleaning solutions. These usually consist of turpentine or petroleum distillates.

The workers in the dye house the color room and the color kitchen sometimes use turpentine petroleum distillates, bleaching powder and strong soaps to remove dye from their hands. The use of these substances has been proved in numerous cases to be the cause of dermatitis at first suspected to be caused by the dyes.

Stains and dirt which gather on the material while passing through the factory are taken off in the cleansing department. The stains are removed by the use of such chemicals as benzene, naphtha, and carbon tetrachloride Dermatitis sometimes occurs among the cleaners whose hands are wet with these fat solvents.

Some of the material is dyed by stencil dyeing This consists in placing a metal or wooden pattern over the silk and spraying the dye through the pattern on the stencil

No cases of dermatitis in this operation were seen in the factory inspected in this country Otto Schulz reported 20 cases of poisoning in Germany among women workers in a textile factory where stencil dyeing was done on silk. The dyes investigated contained considerable quantities of lead and were dissolved in xylene. The workers were employed from six to eight weeks before symptoms of poisoning appeared and stippled cells characteristic of lead poisoning were found in all cases.

COTTON DYEING

Cotton is dyed in a manner similar to that described for silk. The principal dyes used for cotton are the direct cotton dyes mordant dyes vegetable dyes, ice colors and aniline black.

The same hazards described for silk dyeing apply to cotton dyeing except that cotton is never loaded

ARTIFICIAL SILK DYEING

Nitro silk, cupramonium silk, and viscose silk are made of regenerated cellulose and have the same affinities for dyes as does cotton. They can be dyed with the same class of dyes as used for cotton. However cellulose acetate is an ester and behaves differently towards dyes than do the other artificial silks It requires different methods of dyeing Certain chemicals such as ammonium thiocyanate or sodium hydroxide are required to treat the silk to render it capable of taking up the dyes which the other artificial silks take up. Special dyes have been prepared which have an affinity for cellulose acetate such as the cellutyl dyes and the ionamines A special class of dyes which are colloidal suspensions have been developed for dyeing cellulose acetate The cellanthrene dyes are examples

WOOL DYEING

The principal dyes used for wool are the acid dyes and dyes used with basic mordants. The acid dyestuffs are nitro compounds or sulphonic acids. Woolen piece goods are usually dyed in a boiling acid dye bath to which sulphuric acid is added The sulphuric acid produces lanugic acid in the wool and this is the substance which is really dyed by the free acid dye which is liberated from its salt (the acid dyes are sold as sodium or calcium salts)

White wool tops and woolen yarn are usually dyed by the use of acid chrome mordants They are placed in a large kettle and wet with hot water The diluted dyes either natural such as logwood or synthetic such as the alizarin dyes are added together with acetic acid The kettle is then closed and heated to a boil Then a solution of potassium bichromate which may contain formic and lactic acids is added and the kettle again brought to a boil The chemicals penetrate and combine with the wool so that very little fluid is left in the kettle The material is lifted out of the kettle soaped rinsed and dried in suitable machines. Aluminum iron tin or antimony mordants may be used instead of chromates An example of dyeing directions for chrome colors is as follows

The material previously scoured is entered into a cold or lukewarm bath containing the required amount of color 15 pounds of Glauber s salt and 2 pounds of acetic acid After working for ten minutes the bath is slowly raised to the boil and kept at this temperature until it is exhausted The bath is cooled the necessary amount of sodium bichromate (this amount should never exceed

one-half of the total weight of the dyestuff used) is added and the bath is again boiled for one-half hour The goods are then rinsed dried and finished. For metachrome dyeing the sodium bichromate is added simultaneously with the dye.

In a wool dyeing establishment chrome ulcers of the nasal septum were seen especially among the men who issue chemicals. The dust stirred up when chromates were weighed and issued was the cause

In the wool dyeing factory examined the 2 men employed as weighers and issuers of chemicals both had ulcers of the cartilaginous portion of the nasal septum. No nasal ulceration was seen among the dyers in this factory This was probably due to the fact that chrome dyeing was done in enclosed kettles and no fumes or steam containing chrome vapors entered the room However among 34 men who handled wet dyed wool in this factory there were 2 cases of erythematous vesicular dermatitis of the hands and fingers. Patch tests with the various solutions used in dyeing which these men handled showed hypersensitivity only to the solutions of potassium bichromate and chrome mineral colors.

Selaky described the occurrence of some 200 cases of industrial skin lesions due to the use of antimony in cloth dyeing and he stated that he believed these lesions were due to the acid intermediate products which were formed when antimony salts were used as mordants.

A sudden outbreak of dermatitis occurred in a woolen mill 133 cases among 1 727 workers. The largest percentage of cases being in the card room dye house washing room and waste-room where there were 70 cases among 333 workers.

The outbreak began when the concentration of sodium dichromate in the dye bath was raised from 0.5 to 3 per cent in order to meet the government specifications for woolen blankets.

The process for making the wool blanket is briefly as follows

Raw wool is received as bales of fleeces the separate fleeces are opened on a table and the wool from various portions of the fleece is separated into five grades by a wool sorter The grade wool is passed through a dusting machine that knocks the gross dirt from the wool fibers and the wool then is placed in a five-bowl scouring machine where it passes successively through a soap solution a solution of soap and soda ash, and finally clear water If the wool is sufficiently free of foreign matter after this process, it is passed through a dryer and then blown through a duct to the baling room Wool that still contains considerable foreign material after scouring is carbonized by passing it through a bath of approximately 5 per cent sulphuric acid It may then be rescoured dried and blown to the baling room

Bales of wool are taken to the stock room of the dye house as needed. Wool is dyed in Franklin process kettles under 5 to 8 pounds pressure at about 220° F The dye bath for khaki dyeing consists of sodium dichromate as a mordant acetic acid an antifelting agent and dyestuffs After dyeing the wool is washed in

water dried and transported to the wool room for storage in bins until needed.

From the wool room the dyed wool is dropped to the blending floor of the picker room Here the wool is spread in layers and then passed through a blending machine where it is blended and oiled with an emulsion consisting of sulphonated mineral and vegetable oils. The blended wool is taken to the carding room where it is placed in carding machines which card the wool twist it into a loose yarn and wind it on spools. These spools of yarn are taken to the spinning room where they are twisted into a thread on ring spinning or mule spinning machines, and wound on bobbins. The bobbins then go to the weaving rooms where the wool thread is woven into a fabric such as blanket material The woven material then goes to the burling room for inspection for defects then to the washing and fulling room.

In the wash room the blanket material is washed in a solution of soap and soda ash in special washing or fulling machines. After washing the blanket material is rinsed and dried in a dryer and girls known as speckers examine the material again for defects The blanket material is then passed through shearing machines to remove loose clumps of wool and sent to the finishing room In the finishing room the blanket material is put through napping machines cut, hemmed stenciled (military insignia) folded and packed for shipment.

Patch tests showed that hypersensitivity to the increased concentration of sodium dichromate was responsible for the majority of the cases in the dye house workers and among those handling the wool after it was dyed The wetting agent used in the dye bath and the strong solution of soap and soda ash used for washing the blankets proved to be primary skin irritants and accounted for a considerable number of cases of dermatitis. The exposure to the 3 per cent dichromate solution produced chrome ulcers in some workers and dermatitis in others who had not been previously affected by 0 5 per cent dichromate solution or who had become 'hardened' to it. The following preventive measures controlled the outbreak.

Workmen in the dye house should wear long wide rubber aprons long rubber gauntlets and rubber boots to minimize contact with the solutions used in the dye vat and with the wet wool.

All dye house workers should be required to take a cleansing shower bath at the end of the day's work. Clean work clothes should be provided for the workers twice a week

Carders should also wear rubber aprons and sleeves of some impervious material (such as Pliofilm Vinylite Koroseal) and leather gloves. They should take cleansing showers after work and have clean work clothes provided twice a week. *If the wool could be handled with a specially designed tool similar to a many-pronged ice tong or a pitch fork much of the contact with the wool which now occurs would be eliminated* Washing facilities should be

provided for the strippers of the carding machines so that they can wash hands, forearms and face whenever they finish stripping a machine.

Workers in the wash room should wear long rubber aprons rubber gauntlets impervious sleeves, and rubber boots to protect them from the strong alkaline solution. They should take cleansing showers after work and apply to their hands a mixture of 70 per cent anhydrous lanolin and castor oil to help replace the fat taken out of the skin by the strong alkaline washing solution.

CHAPTER XX

DERMATITIS FROM WEARING APPAREL

Dermatitis from most types of wearing apparel has been reported usually as isolated instances. On occasions, however large outbreaks have occurred among the general population because of the sale of new materials containing substances of unknown toxicological properties which were placed on the market before testing for action on the human skin

Among articles of wearing apparel dermatitis has been reported from fabrics such as silk wool and synthetic fibers from leather artificial leather furs rubber and rubber containing materials such as rubber gloves dress shields and girdles socks, pajamas brassieres and many others. Metal and metal alloys used in jewelry and in eye glass frames, wrist watches and straps have also caused dermatitis. Plastics used in spectacle frames wrist watch straps garters and suspenders have also been reported as causes of dermatitis.

FABRICS

While occasional cases of dermatitis have been reported as due to sensitivity to some of the unprocessed fabrics such as silk and wool the majority of the reported cases of dermatitis due to wearing of fabrics have been caused by the processed fabrics.

Fabrics as worn by the public consist of the basic fabric itself and all the chemicals which have been placed on them or in them such as dyes and finishes in order to make them salable or suitable for wearing purposes.

Sensitivity to Unprocessed Fabrics.—Sensitivity to silk has been reported Most of the reported cases were from processed silk. Very few authors differentiate between sensitivity to the raw silk and the chemical with which it was treated. The type of eruption described by most of the writers was of the urticarial type Urbach described an actual case of contact dermatitis from unprocessed silk

Fabrics made from wool camels hair and other animal hairs, have been reported as causes of allergic contact dermatitis. There are no cases of dermatitis reported from unprocessed fabric made from vegetable fibers such as cotton and linen although dermatitis has been reported as occurring among pickers of flax and also from cotton-seed oil (oil of gossypii)

A review of the literature of sensitivity to so-called basic fabrics shows that in most instances the sensitivity tests on which the diagnoses were made were performed not with the actual raw materials, but with undyed or unfinished fabrics so-called gray goods, which are already partially processed Perhaps another fallacy in some of the reported tests was failure to distinguish

between the physical irritation caused by "wooly" or rough fabric and an actual allergic reaction. As a corollary, a dermatitis may be caused by the friction of a rough material where a patch test for the purpose of demonstrating sensitivity would be negative. In such cases the cause may be the mechanical friction resulting from actual wear.

SYNTHETIC FIBERS

Fabrics for wear are made of processed cellulose (rayon), of a number of synthetic resins, glass and casein.

Cellulose.—From cellulose is manufactured the various rayons such as viscose rayon and acetate rayon. While many cases of dermatitis have been reported among the wearers of these rayons, all the cases were from the finished product and not from the unprocessed material.

Synthetic Resins.—The best known of the purely synthetic resin fabrics are polymers made from hexamethylenediamine and adipic acid, and sold under the trade name of Nylon. Although some cases of dermatitis from nylon were reported, it was shown that these cases were all caused by a certain finish and not the nylon itself. Fabrics are now being made on a small scale from vinyl and styrene resins, as well as from fiber made from casein. No cases of dermatitis have been reported from them.

Glass.—Glass is now being spun into fiber. In order to make these fibers suitable for weaving into fabric certain resins are used on them. Cases of dermatitis have been reported from such glass fabrics. These cases are due to the resins or the mechanical irritation of the rather sharp fibers and not to allergy to the glass.

Glass wool is made for insulating purposes. Dermatitis occurs in its manufacture and in its use, caused by the mechanical irritation of tiny sharp glass slugs, and occasionally from sensitivity to the resin binder (phenolformaldehyde) which it contains.

Synthetic Films.—Some of the plastics in sheet form are used for protective clothing. Some of them are also laminated onto cotton or other natural fabrics in order to make them impervious. Rubber hydrochloride, vinyl resins, acrylic acid resins, and cellulose acetate are used for these purposes. Dermatitis has been reported from the vinyl, the acrylic acid, and the rubber hydrochloride films, but in all these cases it was due either to plasticizers, or stabilizers used in the films.

The following plasticizers, stabilizers, and modifiers, have been causes of dermatitis:

Tricresylphosphate	Dibutyl tin laurate maleate
Triphenylphosphate	Phenyl salicylate
Dibutyl sebacate	Resorcin-formaldehyde combination
Dibutyl tin dilaurate	

RUBBER

Dermatitis from wearing apparel made of rubber has been reported. Gloves, girdles, dress shields, gas masks, condoms, etc.

have all been reported to cause dermatitis. In all of these cases it was the compound placed in the rubber such as the accelerator and antioxidants, or compounds formed on the surface of the rubber by "vapor cure" (sulphur mono chloride) which have been the actual irritants not the rubber itself. The following accelerators, antioxidants, etc., have been the cause of dermatitis:

Hexamethylene tetramine
The guanadines
Mercapto benzothiazole
Tetramethyl thiuram monosulphide and disulphide
Para toluidine
Ortho toluidine
Triethyl trimethyl triamine
Phenyl beta naphthylamine } Antioxidants
Monobenzyl ether of hydroquinone (leukoderma) } Antioxidants

The accelerators named above are contained in many rubber articles which do not cause dermatitis. They only cause dermatitis when they are contained in the rubber in such quantities that they "bloom" out or if they are so loosely incorporated that they can be leached out by the perspiration. The same applies to the antioxidants except monobenzyl ether of hydroquinone. This chemical can cause leukoderma even when it is properly incorporated into the rubber.

Dermatitis from "vapor cured" rubber is caused by the fact that continuous changes take place on the surface of vapor cured rubber and these changes result in the formation of sensitizing chemicals. Those who develop dermatitis from wearing vapor cured gloves (surgeons) may prevent dermatitis in the following manner: Soaking the gloves in a 5 per cent solution of sodium carbonate for fifteen minutes and then rinsing in water, sterilizing by dry heat, and wearing them dry and well powdered on the inside of the gloves every time the gloves are to be worn. The same procedure should be adopted by those sensitive to rubber gloves made directly from latex because in such gloves the accelerators and antioxidants are more easily leached out by the perspiration.

Synthetic Rubber.—There are several types of synthetic rubber. The first one made in America was Neoprene, which is made from acetylene. There are now being manufactured Buna S made from butadiene and styrene, Buna N made from butadiene and acrilonitrile, and butyl rubber made from butylene and isoprene. Although these synthetic rubbers have been on the market for a comparatively short time and little wearing apparel, mostly gloves, has been made from them, some cases of dermatitis have been reported.

These synthetic rubbers are processed in the manner similar to that used for processing natural rubber and contain accelerators and antioxidants and other compounds, cured by heat as well as by sulphur monochloride. Most of the cases of dermatitis from synthetic rubbers are probably caused by the same compounds as cause dermatitis in natural rubber, although synthetic rubber does contain sensitizing substances not present in the natural rubbers.

DYES AND MORDANTS

Dermatitis due to fabric dyes is relatively infrequent among the wearers of the fabrics. For some time it was the common impression among physicians that dermatitis due to wearing apparel was caused by the dyes in the fabrics.

When dermatitis is caused by the dyes it is usually due to an idiosyncrasy to the dye itself or to a faulty process of dyeing so that there is retained in the fabric some chemical which should not have been present. On occasions, dyes will cause dermatitis if one of the known sensitizing dyes are used

When dyes themselves have been found to be the cause of the dermatitis it has been usually found that they easily come out of the fabric or "bleed." Conditions on the skin surface may help to determine the "bleeding" of the dyes from the fabric. For instance some will bleed out in acid perspiration and others in alkaline Since some of the dyes are soluble in fat solvents a high fat content on the skin surface may help dissolve them out. It is also to be borne in mind that the dye intermediates are more likely to cause dermatitis than the finished dyes themselves, and that under certain conditions such as the heat of ironing some dyes will break down into their intermediates.

Faulty dyeing process may cause dermatitis by leaving in the fabric some chemical irritant which should have been removed as for instance in vat dyeing or in mordant dyeing the excess of the oxidizing or mordanting bichromate should be removed before the dyeing is finished otherwise dermatitis may occur on those handling or wearing the fabric. Wool is often dyed by the aid of a mordant. Mordants are also used in certain dyeing processes other than wool dyeing Of the mordants it is the dichromates which have caused dermatitis. The following dyes have been reported as causing dermatitis

Amino-azo-benzine	Methyl violet
Auramine	Malachite green
Brilliant indigo 4G	Orange R
Crystal violet	Orange Y
Chrysoidine	Ponsol dark blue B R
Hydron blue	Sulphanthrene pink F F
Iso-rosinduline	Safranine
Indanthrene violet R R	Victoria blue
Ionamine A	Victoria green
Metanil yellow	Resorcinol component dyes

Special dyes are used for dyeing of rayon because the ordinary dyes do not easily penetrate the comparatively solid rayon fabric. Dermatitis has occurred from these special acetate dyes.

FABRIC FINISHES

It has been shown that in most instances the dermatitis among the wearers of fabrics was caused by the finishes rather than by the dyes.

Finishes are placed in fabrics for the following reasons To give them a better appearance such as luster better feel and wearing properties to prevent runs and unravelling to make fabrics noncreasing and sometimes to hold the crease, to make them waterproof mothproof flameproof moldproof and insectproof Some of the finishes stay more or less permanently in the fabric. Other finishes are easily removed by the laundering and only a small part may remain after many washings. For this reason finishes which are removed by laundering are reapplied after each laundering

Starches and sulphonated castor oil were the first finishes used and were applied to enhance the appearance and the feel of the fabric and thus increase its selling appeal. Dermatitis has never been reported from starch but Schwartz showed that an improperly neutralized sulphonated castor oil (alkalinity) was the cause of a dermatitis from socks.

Anti-wrinkle and Crease Holding Finishes.—More recently certain resins are applied as finishes to make the fabric resistant to wrinkling or to hold its crease and in the case of stockings, to prevent runs. These resins are usually applied in the dye bath and consist of modified natural or totally synthetic resins. Schwartz, *et al* showed that an outbreak of dermatitis thought at first to be due to a synthetic fabric was really due to a finish containing an ester gum This finish was used on other fabrics and caused dermatitis.

The new synthetic resin finishes have caused a number of cases of dermatitis. The resins are applied from solutions or emulsions which leave a thin film of the resin on the fabric after evaporation of the solvents. The rosins, ester gums, the formaldehyde type, methyl methacrylate vinyl, styrene, and glyptal resins may be applied in this manner Some of the resins when applied in the form of emulsions containing uncured or partially cured resins are completely cured in the heat of the finishing bath and in the heat of the boarding process.

Completely cured resins do not as a rule cause dermatitis. When complete polymerization and stabilization does not occur there may be enough free monomers or uncured resins remaining on the fabric to cause dermatitis in sensitive cases. Actual sensitization by the fabric can occur also.

Glycerine-phthalic anhydride resins are used in emulsions containing alkali such as ammonia or sodium hydroxide or tri-ethanol amine These resins may also contain impurities which are skin irritants.

The dicyandiamine-formaldehyde resins may undergo decomposition to form methylamines which may cause dermatitis. Other resins which cause sensitization dermatitis may be introduced into use as fabric finishes

Waterproof Finishes.—In some of the older methods of waterproofing fabrics (1) the fabric was placed in the soap bath followed by alum or other aluminum salts in water solution in order to deposit

aluminum soap on the fabric or (2) an application of aluminum or lead soap from an organic solvent such as benzene was made. There are no recorded cases of dermatitis from the finished materials proven to be due to waterproofing agents containing these insoluble metallic soaps.

In still another method of waterproofing the fabric after dyeing and drying is then passed through a solution of paraffine dissolved in a petroleum solvent and again dried over hot cylinders. When Japan wax was used instead of paraffine, dermatitis was seen from such coated fabrics because Japan and China wax are derived from a tree of the poison ivy family (*Rhus vernicefera*).

Fabrics have been treated with tar resins and rubberized in order to make them waterproof. Dermatitis has been seen from such materials only among the processors of the fabrics.

Flameproofing.—Canvas and leather gloves, sleeves, and aprons are used as a protective by welders to protect them against sparks. These materials may be treated with flameproofing chemicals. Asbestos is also used. Wearers of asbestos do not have dermatitis from it as it is not worn next to the skin.

Cotton and silk are often flameproofed by treating with chlorinated naphthalenes, ammonium sulphamate, boric acid and borate, diammonium phosphate, antimony chloride, etc. Although workers making clothing from these materials sometimes develop dermatitis and workers processing fabrics with chlorinated naphthalenes may develop chloracne, cases of dermatitis among the users of these fabrics have not been reported.

Delustering Agents.—Zinc sulphate, barium sulphate, aluminum sulphate, and titanium oxides are some of the chemicals used as delustering agents. No dermatitis has been reported from their use.

Mothproofing and Antilousicides.—Silico fluorides are most frequently used for mothproofing although the chlornaphthalenes (naphtha balls), chlorbenzene, chlorphenols, synthetic camphor and others are also used. The solutions of silico fluorides are usually sprayed on the fabrics. The chlornaphthalenes and camphor used in the form of flakes or balls are placed in the clothes or closets. Dermatitis has not been reported from fabrics exposed to these substances.

Since the outbreak of World War II, it has been found desirable for sanitary reasons and as a protective measure against typhus to treat clothing of our Armed Forces with chemicals known to kill lice and other related insects. The most widely used and effective agent at present is DDT (dichlordiphenyl trichlorethane). It can be used alone or in combination with other insecticides. Other insecticides such as pyrethrum, rotenone (the active principle of derris and cubé) and synthetic insecticides may be used.

The synthetic insecticides are usually primary irritants in strong concentrations, and the natural insecticides are sensitizers.

Anti-mildews.—With the advent of the war it has been found necessary to mildewproof many articles of clothing and equipment

made of fabric and leather to prevent their deterioration in tropical climates. Tenting hammocks, camouflage and mosquito netting knapsacks, canvas covers of all types, and interlinings of shoes, and many other articles have been treated with mildewproofing agents. They are so precipitated on the fabrics that they will be retained after many washings. While many chemicals are excellent fungicides, they cannot be incorporated into articles of clothing or equipment which are to be in close contact with the skin because they are primary skin irritants and sensitizers in the concentrations in which they satisfy anti-mildew performance specifications against molds. Even if such irritant chemicals are incorporated into materials which are not to be in contact with the skin such as sandbags and tenting, etc., they have been the causes of dermatitis to the workers making those materials. This does not imply that such chemicals should not be used in fabrics which will not be worn next to the skin

We have tested many of the compounds which have been suggested by our Armed Forces as mildewproofing agents by means of the "prophetic patch test." Actual field trials have supported the value of this procedure, when properly carried out, to rule out the use of those chemicals which would cause dermatitis.

The following mildewproofing agents in the incorporated concentrations given have been found to be skin irritants

Phenyl mercury acetate	0 1% of weight of material	
Pentachlorphenol	1 0% "	"
Tetrachlorphenol	1 0% "	"
2 chlor 6 phenyl phenol	1 0% "	"
Dihydroxy dichloro diphenyl methane	0 45% "	"
Alkyl phenoxy ethoxy dimethyl benzyl ammon chloride	1 0% "	"
Trichlorphenate	2 0% "	"
Copper naphthenate	1 0% "	"
Copper palmitoleate	1 0% "	"
Aminoguaicol benzothiazole aminourea	1 8% "	"
Salicylanilide	0 5% "	
Phenyl mercury lactide	0 45% "	"
Phenyl mercury lactate	0 4% "	"
Tetra brom orthocresol	0 45% "	"
Para nitrophenol	0 5% "	"
Phemerol (formula)	4 0% "	"
Phenyl mercuric phenolate	0 25%	"
Mercapto benzothiazole	0 45% "	"

When some of the anti-mildews given above were used on fabrics which were also waterproofed by superimposing a wax the patch tests were negative because the anti-mildew did not come in contact with the skin However under some conditions of manufacture the workers would have sufficient contact to cause dermatitis when the superimposed waterproofing material was rubbed off after continual friction with the worker's skin thus exposing them to the action of the anti-mildew

LEATHER

Dermatitis among leather workers is not infrequent because of the many primary irritants and sensitizers used in processing the hides to convert them into leather. However the incidence of dermatitis due to wearing and handling leather goods is small compared to the millions of users. Dermatitis has been reported from hatbands gloves, wrist watch straps pocketbooks, furs, and other leather articles.

Many of the chemicals used in processing hides to convert them into leather may be the cause of the dermatitis, but the tanning agents and the dyes have been found to be the most frequent causes of the dermatitis among the wearers and handlers of the finished leather goods. Recently another source of dermatitis among those exposed to the finished leathers has been introduced by the addition of mildewproofing agents to the leather. We have encountered a number of instances of dermatitis due to these chemicals but as yet leather containing the mildewproofing agents has not been used for a sufficient time by the general public for reports of such cases to have appeared.

The majority of the cases of dermatitis due to contact with leather have been of the allergic type. The sensitizing chemicals may have been dissolved out of the leather by water or perspiration.

The sensitivity may have been acquired by contact with the chemicals in the leather or the sensitivity may have resulted from previous contact with similar chemicals used in other articles of wearing apparel.

The following substances remaining in the leather may be causes of dermatitis.

Bismarck brown Amido-azo-benzene Amido-azo-toluene hydrochloride Chrysoidine	Dyes
Chromates Oak Sumac Quercitron	Tanning agents
Fish oil Castor oil Resins	Finishes

Anti-mildew and Fungicides.—We have found leather in which the following chemicals were used as anti-mildews capable of producing dermatitis.

Mercapto benzothiazol Tetrabrom ortho cresol Paranitrophenol Pentachlorphenol Salicylanilide Dihydroxy dichlor diphenyl methane	Anti-mildews

Lollar performed patch tests with seven anti-mildews contained in leather in concentrations of 0.75 per cent and less, and obtained reactions from the following

Para-chloro-meta-cresol
Phenyl mercuri-acetate
Ethyl mercuri phosphate
Puratized N-5-X (organic mercurial)

Artificial Leather.—Materials designated as artificial leather may be made from cotton fabrics covered by cellulose nitrate and vegetable oils, synthetic resins, rubber solution, or latex may be impregnated into cotton or loosely felted papers or napped soft felted fabrics. In some instances, the cotton fabrics are covered with plastics. Sheets of artificial leather may be made from loose fibers and scrap leather which are compressed after mixing with linseed oil. The grains of the different leather are then put on the surface by embossing machines or engraved press plates. Concentrated uncoagulated pastes of compounded latex and fibers are dried, pressed and vulcanized in another process of making artificial leather.

Dermatitis may occur from such artificial leather from the dyes, the resins, the formaldehyde, sulphur, the antioxidants, and other chemicals used in its manufacture.

Shoes.—Dermatitis from shoes has been frequently reported in the literature. A number of instances of dermatitis from the shoe polish have also been observed. Such instances were more frequently reported in the European Literature probably because the American public is not in the habit of polishing their own shoes as much as the Europeans. It is hard to conceive of a dermatitis from the outer leather of the shoes since there is very little contact with the skin of the foot. The chemicals incorporated in the outer leather would have to go through the backing and through the socks in order to produce a dermatitis.

The inner lining of the shoes as well as the backing contain chemicals which may cause dermatitis. The backing of the shoes contains adhesives, anti-mildews, and fungicides. In a number of instances artificial leather may be used on the inside of the shoe.

FURS

There are many reported instances of dermatitis due to the handling and wearing of furs. While a dermatitis among the wearers of furs may occur from the mechanical friction of the coarse hairs against the skin, or to a sensitivity to the unprocessed fur, such occurrences are rare. In the majority of such cases it is due to the dyes and the tanning agents.

Since the non-hairy hide of the pelt is covered by lining, only the fur itself comes in contact with the skin. Thus, the chemicals used for tanning and dressing the fur rarely cause dermatitis, especially since they are present in only traces in the hair of the fur.

It is the dyes and the mordants used with them which are applied to the hairs that cause the dermatitis from the wearing of furs. It necessary for the wearer to be sensitized to these chemicals before the garment is worn or to have been sensitized by wearing the garment in order to develop dermatitis. Furthermore in order to cause a sensitivity the furs must be so poorly dyed that they are leached out by perspiration or moisture It is possible that once sensitivity has developed even a well dyed fur may cause dermatitis.

Paraphenylenediamine has been the chief cause of dermatitis from fur The other oxidizing dyes, aniline black and ortho amino phenol may also cause it. The chrome mordants are also possible etiologic factors.

Paraphenylenediamine is a white crystalline substance which itself is comparatively non-irritant. In using it for a fur it must be oxidized The first oxidation product is said to be quinone diamine which is an unstable compound capable of producing local irritation of the mucous membranes This chemical is said to be the actual cause of dermatitis from paraphenylenediamine. Further oxidation results in the formation of a chemical known as Bandrowski's base which is not yet the final black oxidation product but is not supposed to be irritant.

The reduction of the incidence of dermatitis among the users of furs is in the hands of the dyers. In recent years they have been aware of this fact and have processed the furs with greater care so that now we rarely see reports of cases. The preventive measures used by the dyers include the use of weak solutions of the dyes frequently applied or applied for longer periods rather than concentrated solutions for short periods the careful oxidation of the dye and the thorough removal of excess or unoxidized dyes by washing and drumming

JEWELRY

Dermatitis from jewelry has been reported In most instances it was due to metallic jewelry but dermatitis can occur from some of the modern jewelry made from various plastics and other materials. Cases of dermatitis from earrings, necklaces lockets, watches, and spectacle frames have been reported

Most of the reported cases of dermatitis from metallic jewelry were attributed to the nickel. Such cases of nickel sensitivity were found among the wearers of watches and spectacle frames made of nickel alloys, among which is the so-called white gold.

Schwartz and Tulipan report sensitization to platinic oxide in a worker handling this material but we have been unable to find any instances of dermatitis in the literature from the wearing of platinum jewelry

Andrews shows a photograph with the legend *Dermatitis from chromium wrist watch* No particulars as to the exact cause of the dermatitis are given.

FEATHERS

Contact dermatitis from feathers in wearing apparel is a rarity since most of the wearing apparel made from feathers are used as ornaments on hats etc and there is very little contact with the skin. In the past contact dermatitis due to feathers has been reported mainly among children who had contact with the feathers in pillows and bedding

DIAGNOSIS

Dermatitis from wearing apparel is not difficult to diagnose. The eruption begins at the place of contact with the offending material usually five days or more after the garment has been worn. This is the period of incubation for the sensitivity to be established The eruption may appear sooner if the person is already sensitive to the chemical in the wearing apparel which causes the dermatitis. The eruption is usually confined to the areas of the skin touched by the offending material In exceptional cases, however a generalized eruption may be present and sometimes systemic symptoms such as elevation of temperature may accompany the dermatitis.

It is recommended that the following facts be ascertained in order to make a etiologic diagnosis

1 When did patient buy the wearing apparel?
2 From what firm?
3 Date when wearing apparel was first worn.
4 Date when eruption began
5 What parts of body were first affected?
6 Extent of eruption
7 Description of eruption
8 What previous skin diseases?
9 Has patient any history of allergy of the skin or the mucous membranes?
10 Were any drugs taken before the present eruption?
11 Was poison ivy or other irritant plant contacted before present eruption?
12 Is the eruption still present?
13 How long after the patient stopped wearing the apparel did the eruption persist?
14 Were patch tests performed? Give details. Results?
15 Has the actual chemical in the wearing apparel causing the dermatitis been discovered?
16 What method was employed for determining the actual chemical causing the dermatitis?
17 Give basic facts on which the diagnosis of dermatitis from wearing apparel was made.
18 What treatment was given?
19 Prognosis

PATCH TEST

The patch test properly carried out and interpreted is the most practical method for demonstrating the actual cause of a contact dermatitis It has been recently used by manufacturers to determine the possible skin-irritating or sensitizing properties of wearing apparel containing new chemicals before placing them on sale to the public

Technique of the Patch Test.—Before an attempt is made to describe the methods used for patch testing clear distinction must be made between substances which are primary skin irritants and those which will be called sensitizers. It is obvious that a concentrated solution of a strong acid or alkali will burn or inflame any skin, the degree of injury depending on the concentration of the irritant the amount applied the duration of its action, and the area to which it is applied.

A group of dermatologists acting as consultants to the Public Health Service have defined a primary skin irritant as follows

> *A primary cutaneous irritant* is an agent which will cause dermatitis by direct action on the normal skin at the site of contact if it is permitted to act in sufficient intensity or quantity for a sufficient length of time.

Many chemicals which are primary irritants are also sensitizers for instance, formaldehyde, alkaline bichromates, mercuric salts, phenols, etc.

It is obvious that patch testing with strong concentrations of known primary irritants will result in reactions on any skin. This does not mean that patch tests should not be performed with dilute solutions of chemicals which in strong concentration are primary irritants There are published lists of concentrations of chemicals which dermatologists have used to determine hypersensitivity these concentrations, together with the time they are to remain on the skin, are recommended in an attempt to avoid the primary irritant action of the chemical

The chemicals which are not primary irritants are responsible for the great majority of cases of contact dermatitis caused by wearing apparel cosmetics ornaments etc. They induce a specific skin allergy and thus cause dermatitis.

They may be called sensitizers and were defined as follows by the group of consultant dermatologists referred to above

> *A cutaneous sensitizer* is an agent which does not necessarily cause demonstrable cutaneous changes on first contact but may effect such specific changes in the skin that, after five to seven days or more, further contact on the same or other parts of the body will cause dermatitis.

Substances which are only sensitizers need not be diluted for patch test purposes.

The patch test when used for diagnostic purposes consists in applying a small portion of the suspected substance to a site of normal skin of the patient. This is covered with innocuous impermeable material which is then sealed to the skin by adhesive plaster There have been many modifications proposed in order to overcome certain objections.

The diagnostic patch test is performed in the following manner

With Liquids.—Saturate a piece of 4-ply gauze ½-inch square and apply it to uninflamed skin on the arm or back. The liquid from the gauze should not be permitted to trickle from the patch site

For insulation a 1-inch square of non-waterproof cellophane is used (Waterproof cellophane consists of regenerated cellulose coated with a water insoluble resin.) This is sealed to the skin with adhesive plaster about 2 inches square. When smaller pieces of adhesive plaster are used patches are often lost or there is insufficient contact between the test substance and the skin The reactions which may result from the adhesive plaster are separated from those resulting from the test substance by the uninflamed skin which is in contact only with the cellophane. In performing a number of patch tests, care should be taken to avoid overlapping of adhesive plaster as this will cause intensification of the adhesive plaster reaction

With Powders —In performing patch tests with powders the powder is placed on a piece of gauze in order to keep the reaction localized If the gauze is moistened it holds the powder better than when dry

With Solids —When solids insoluble in water are used it has been found best to dissolve them in a solvent, making a saturated solution and wetting a piece of gauze with this solution The gauze is then allowed to dry before being placed on the skin in order to eliminate the action of the solvent. This procedure deposits the precipitated finely divided substance on the gauze, and brings about better contact with the skin.

When the insoluble solid is of a resinous character the solution may be painted directly on the skin the solvent allowed to evaporate and the cellophane and adhesive plaster applied If the resin adheres firmly to the skin it is not necessary to cover it with the cellophane and adhesive.

It is usually sufficient to leave the patch on for twenty-four hours but sometimes when patching with low concentrations or with weak sensitizers it may be necessary to leave the patch on for three or four days, but not for more than five days as the patient may by that time become sensitized to the patch itself This is especially true of fabrics which contain no strong irritants and to which most people do not react. The reactions should be read not only upon the removal of the patches but every day for at least five days thereafter This is of special importance in testing fabrics. A later reaction indicates a lesser degree of sensitivity than an early reaction

Patch Test With Articles of Wearing Apparel

Fabrics —A piece of the fabric about 1 inch square may be left on for two to five days The reaction should be read each day up to three days after the removal of the patch. Best results are obtained while the dermatitis is still present. If the patch test is positive the substances incorporated in the material can be ascertained from the manufacturer and tests performed with each of them If this is not possible the following procedure can be taken to roughly determine the class of allergens involved

Soak the fabric in warm slightly acid water for twenty-four hours to see if the dye bleeds. If it does, the water extract can be concentrated in vacuo and then a patch test can be made with the concentrated dye. In case the fabric is known to be flameproofed the flameproofing chemical (if soluble in water) is in the solution. If the water extract is colorless whatever remains after concentration or evaporation is the water soluble finish. Perform patch tests with this.

To remove the water insoluble finish, soak the fabric in ether for a few hours allow the ether extract to evaporate on a watch crystal and patch test with the residue.

If possible, perform a patch test with the gray goods, i. e cloth before any dye or finish is applied. This is important to pick up the rare cases of sensitivity to wool cotton, or silk

Furs.—In patch testing with fur the test should be carried out with the hairy side of the fur If it is positive, rub the fur vigorously with a piece of gauze and should the gauze become discolored, the fur is so-called "dirty fur A patch test should then be carried out with the gauze discolored by the dye While most cases of fur dermatitis are due to dye[1] a dermatitis due to fur itself may be found occasionally

Leather—The first step in carrying out the patch test is to determine whether the leather is real or artificial This can often be determined by tearing the leather To test the leather moisten a piece about ½-inch square with the patient's own perspiration from the axilla or with a solution approximating the sweat in pH and patch test in the usual way A positive patch test indicates a sensitivity to something in the leather

To determine whether the dye is the cause of the dermatitis, soak a piece of the suspected material in water having the same pH as perspiration. The material is left in the solution for about an hour and if the dye is dissolved it is said to "bleed Evaporate in vacuo and patch test with the concentrated dye. If this reaction is negative the previously positive reaction indicates that there is a sensitivity to the tanning agents or other chemicals which are not easily dissolved out with water

To test the finishing oils or fats as possible causes of dermatitis, soak the leather in ether for fifteen minutes, pour off the ether into a water glass, evaporate to dryness, smear a piece of gauze with the fatty deposit and apply to the skin

The other chemicals in the leather can be traced by patch testing with the leather in different stages of manufacture

If the leather is artificial the celluloid rubber plasticizer dye or synthetic resin may be dissolved out by a solvent and used for patch tests.

Shoes—In investigating suspected causes of dermatitis due to foot-wear it is useless to patch test with the material on the outside of the shoe

In investigating a shoe dermatitis, patch tests should be made

with the backing In some instances the leather on the inside of the shoe such as the tongue the inner sole and the sock lining may be the cause of the dermatitis, but rarely if ever the outside leather The chemical which causes the dermatitis must get through the sock or the stocking Therefore it is worthwhile to patch test with the sock or stocking (before washing) which should contain the eliciting agent.

Rubber —In patch testing with sponge rubber care must be taken to test with the spongy and smooth surfaces, as in many instances there are differences in reactions obtained from these surfaces.

The dermatitis due to dress shields is often caused by the rubber which they contain the active irritant is usually the chemical formed on the surface as a result of the acid or vapor cure Cases of leukoderma in the axilla have occurred from the antioxidant (mono benzyl ether of hydroquinone) in the rubber portion of the dress shield

In cases of dermatitis suspected to be caused by elastic girdles, patch tests should be performed with the rubber in the thread as well as with the fabric. The rubber used in girdles is usually made in the same manner as the thin rubber of dress shields.

Jewelry —In testing with jewelry first test with the suspected material itself Articles are rarely if ever made of the pure metal and even the so-called pure gold and platinum jewelry contains other metals. It is necessary to determine the other metals which *make up the alloy and patch test with each metal In this regard* we wish to call attention to the fact that in testing for nickel sensitivity the five cent piece is not a proper material since it is made of 75 per cent copper and 25 per cent nickel To test for nickel sensitivity a 5 per cent solution of nickel sulphate should be used Similarly a one cent piece is not proper metal for testing for a possible copper sensitivity since a penny in addition to copper contains 5 per cent tin and zinc All of the silver coins contain 10 per cent copper

Provocative Patch Test

When patch testing with a dilute concentration of allergens such as are found in fabrics the reaction in some cases may be negative even though from the history and by actual exposure the allergen seems to be the precipitating cause. If however at the same time the test is performed with the dilute concentration a second patch of a strong concentration is applied, positive reactions will develop at both sites if the actual allergen has been used This phenomenon has been called the "provocative patch test" by the authors.

Prophetic Patch Test

The use of the patch test for the foretelling whether a substance will or will not produce dermatitis is a recent development and may be called the "prophetic patch test." It was introduced by one of the authors to determine possible irritant qualities of new chemicals

used in the manufacture of wearing apparel cosmetics, or other articles coming in contact with the skin. The patch test is made on 200 or more individuals in the usual way Since the chemicals or compounds to be tested are new ones, it is presumed that there has been no previous contact with them

Two series of patch tests are carried out on the same individuals ten to fourteen days apart The first series of tests would give reactions only with a primary irritant or with people who have been sensitized by previous contact with the chemical The second series shows the number sensitized by the first series Experience has shown that even one positive reaction among the second series may indicate that the test substance is a sensitizer which might lead to outbreaks of dermatitis if allowed to be used by large groups of people.

The pieces of material should be at least 1 inch square and allowed to remain on the skin for forty-eight hours. The larger the pieces used and the longer they are permitted to stay on the skin, the more likely we are to approximate actual wearing conditions and the more accurate the results of the test. This, because the subject is being exposed to larger amounts of the chemical the irritating properties of which are being tested In a number of instances we have noted failures to induce sensitivity with a small piece of material ($\frac{1}{4}$-inch square) when we succeeded with larger pieces ($\frac{1}{2}$-inch square)

When and Where to Perform Patch Tests

The impression seems widespread that patch tests should not be performed while an eruption is still present because a flare-up of the dermatitis might take place The period most favorable to a positive reaction is at the time when the dermatitis is still present and active A relative hyposensitivity may develop when the dermatitis is disappearing or after it has disappeared with the result that the patch test would tend to be negative Here too experience and judgment are necessary in choosing the proper time for performing the tests. Obviously when dealing with a patient who has a generalized dermatitis it is better either to wait until the eruption has improved or if the test is carried out while the eruption is present, to use a low concentration of the suspected chemical

A generalized eruption following the patch test indicates a high degree of sensitivity Such eruptions are exceedingly rare Flare-ups of quiescent eruptions are not uncommon following patch tests. These also indicate high degrees of sensitivity

In cases of true allergic dermatitis, the skin all over the body is sensitive and patch tests can be applied at any convenient site The most rapid reaction all other factors being equal will take place on the areas of skin where the keratin is thinnest. The thick keratin layer of the palm and soles not only explains the negative patch test which results at these sites but is the main reason why contact dermatitis is only occasionally seen in these locations.

Interpretation and Reading of Patch Tests

It requires considerable experience to correctly interpret reactions to patch tests

Since the patch test was first employed gradations of the reaction have been recorded by the symbols 1+ 2+ 3+ and 4+ By this method an erythema on the area of skin to which the chemical was applied is indicated by 1+ erythema and edema by 2+, and erythema, edema, papules, and a few vesicles by 3+ erythema edema, many vesicles and in some cases, ulceration are recorded as a 4+ reaction.

The degree of reaction will be greatest at the site of greatest concentration. It is for this reason that weak concentrations of sensitizers must be left on longer They should be observed for at least five days after the patches are removed A reaction not present when the patch is removed but which becomes manifest less than five days after the patch is applied is considered a delayed reaction. The delayed reaction indicates that a low degree of specific sensitivity is present or that a weak concentration of the sensitizer was used To report a patch test reaction properly there should be given (1) concentration of the chemical tests (2) amount of the chemical used (3) area of skin contacted (4) site of application (5) number of days patch test was left on (6) periods after removal of the patch that the readings were made In this way a more comprehensive appraisal of the reaction in terms of the degree of sensitivity can be made.

The true allergic reaction as a rule increases rather than decreases in intensity for twenty four to forty-eight hours after the patch test is removed Reactions of primary irritation with few exceptions tend to subside after the removal of the irritant.

The evaluation of a weakly positive reaction (1+) depends a great deal on the experience of the one making the patch test. In dealing with a fabric or other substance containing a weak concentration of a sensitizer a 1+ or 2+ reaction is very significant This is especially true in industry where dermatitis may not only be due to contact with the sensitizer in low concentration but there may be the added factor of friction with exposure to large amounts of the chemical which is not present in the patch test

A positive reaction which cannot be reproduced later with the same technique indicates that at the time the patch test was performed the patient was sensitive to the concentration and quantity of the chemical applied A 1+ reaction which does not persist for twenty-four hours is probably a false positive or is caused by a mild primary irritant maceration or pressure

A negative patch test does not necessarily rule out the test substance as a causative agent. The negative reaction might be due to one of three causes (1) Under the conditions of the patch test the actual mechanism which produces the dermatitis is lacking i e patch test does not equal actual conditions of wear exposure

friction, perspiration etc. (2) the patient is no longer sensitive (3) the actual sensitizer was not applied

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CHAPTER XXI

COSMETICS

Cosmetics as a class are relatively harmless. Most of the chemicals used in cosmetics are innocuous although some are primary irritants such as hair wavers and straighteners, depilatories and cuticle removers which depend for their action on strong alkalis or keratolytics. The principal factor in cosmetic dermatitis is hypersensitivity leading to an allergic contact dermatitis.

In 1930 Kling reported dermatitis from synthetic dyes used in cosmetics. In 1931 Kesten and Laszlo reported that out of 21 cases of dermatitis venenata, 18 were definitely proven by patch test to have been caused by local cellular sensitization to specific non-proteins acquired by previous contact. The sensitizers were paraphenylenediamine sodium bichromate novocaine potassium and mercuric iodide, primrose poison ivy pyrethrum mascara, face powder and face cream. They did not determine what chemicals in these last three cosmetic preparations were the actual sensitizers

In 1935 Vaughan and Fowlkes reported a case of dermatitis in a man due to perfume carried by his wife.

Krantz in 1936 stated that there is practically no substance to which hypersensitivity cannot be acquired He enumerates hair washes, hair rinses ammoniacal bleaches, hair dyes, lipsticks medicated soaps dental cleansers mouth washes depilatories perfumes, powders freckle removers and nail polishes as causes of dermatitis.

Oppenheim states that the use of all fats as exclusive skin cleansing agents may lead to the formation of comedones and pustules. Especially is this true of mineral fats and waxes such as vaseline and paraffine. Glycerin may cause roughness and fissuring of the skin. He also emphasized dermatitis caused by hair dyes and nail lacquer

In 1937 Rostenberg and Sulzberger performed a series of over 10,000 patch tests in more than 1,000 patients and found that soaps caused more reactions than any other substance tested and that arsenic, nickel sulphate biological agents, halogens solvents metals mercurials, proteins insecticides dyes cosmetics and oils followed in order Of the dyes, the so-called para-reds produced the most reactions. Of the cosmetics face creams rouge, lipsticks, face powders and eye cosmetics did so in diminishing order Hair tonics produced 50 per cent more positive reactions than hair dyes.

In 1937 Koga reported 6 cases of dermatitis in Japan caused by six different cosmetics.

Hazen in 1938 warned against "dry cleaning" hair preparations paraphenylenediamine hair dyes face powder containing tremolite baby powder containing zinc stearate freckle removers containing

mercury and astringents containing phenol He also discussed dermatitis from soap rouge lipstick, deodorants and depilatories.

Tulipan in 1939 discussed the cosmetics reported to have caused dermatitis.

Abramowitsch *et al* call attention to the possibility of contracting fungus diseases in hair dressing parlors. Traub and Goodman reported the case of a boy aged seventeen years who developed a chancre of the neck at the site at which a barber had removed with the aid of forceps, an ingrowing hair

Wolcott states that the majority of injuries from cosmetics belong to the allergic dermatoses. He names aniline dyes synthetic perfumes and nail polishes as possible causes and suggests that the ingredients of cosmetics should be required by law to be listed on the label

Sulzberger and Hecht conclude that in certain instances the impurities in cosmetic dyes may be responsible for the allergic reactions.

OCCUPATIONAL DERMATITIS AMONG HAIRDRESSERS BARBERS AND BEAUTICIANS

Occupational dermatitis among workers engaged in the manufacture of the majority of cosmetics is an uncommon occurrence because the ingredients are usually mixed in vessels and placed in containers by mechanical means. In several of the largest cosmetic manufacturing concerns in the United States employing several thousand workers there were no cases of occupational dermatitis observed at the time the inspection was made

Occupational dermatitis has been reported not infrequently among hairdressers barbers and beauticians which resulted from their handling of cosmetic preparations (Fig 38)

Haxthausen in 1925 reported that although the eczema of hair dressers is usually attributed to soap tar oils etc which they constantly use he observed 3 cases of a persistent eczema localized to the palm and web spaces of the left hand which was caused by the colocynth used as a denaturant in alcoholic hair tonics and brilliantines.

Louste and Thibaut reported dermatitis in the interdigital folds of the right hand of a barber from hairs forced in these areas by the pressure of the scissors.

Karnjeew and Curewitsch noted inflammation of the fourth finger caused by the scissors. They also noted cuts from testing the razor and burns and scars from testing curling irons Subungual keratoses were also observed

Bordas reported an accidental burn in a hairdresser from an inflammable ether compound and advocated the prohibition of the use of carbon tetrachloride and bromethane in cosmetics because of their toxicity

Suponitzkij in 1935 reported 10 cases of dermatitis among hair dressers all caused by the dye Ursol (paraphenylenediamine)

Rothberg and Merrill in 1938 reported a case of occupational dermatitis in a barber caused by boric acid in cold cream.

Tzanck and Sidi in 1940 discussed clinical types of occupational dermatitis in hairdressers and described methods of patch testing and diagnostic criteria.

Rabeau and Ukrainsky reported a case of dermatitis of the hands due to Javelle water. (Javelle water is a solution of sodium or potassium hypochlorite.)

Fig. 35.—Barbers' dermatitis, caused by irritation of hair tonic used on customers.

While cosmetics in general are among the least irritating substances used by the general public, there are chemicals used on the hair and nails which may cause dermatitis if they are permitted to stay on the skin for long periods or if they are unskillfully applied. Hairdressers and beauticians are mostly affected because theirs is the greatest exposure.

Hairwaving and straightening probably causes more dermatitis than any other procedure. The hairwaving and straightening fluids contain alkalis, resins, preservatives, and solvents, which may affect the hands of the operator. Some of these chemicals have a direct and more or less immediate effect on the skin. They are primary skin irritants; such are the alkalis and solvents. Others have a sensitizing effect on the skin which may manifest itself by a dermatitis occurring from a week to several months after the operator has been exposed; such are the resins and the preservatives in low concentrations. Higher concentrations of preservatives may

act as primary irritants and they may have a direct and immediate effect on the skin. The hair waving concentrates sold to beauty parlors are more likely to cause irritation than their dilute solutions which are actually used on the hair.

The permanent waving solution may contain inorganic or organic substances with alkaline reaction such as ammonium salts, borates, carbonates, phosphates, sulphites and aliphatic amines, all of which can affect the skin of the operator, especially if there is prolonged or frequent contact.

Burns of the hands may result from badly insulated wires or from the action of the heat and the chemicals in the heating pads.

The soaps and other detergents used for shampooing may "defat" and irritate the hands of the operator.

Hair dyes, especially the oxidizing organic dyes of the para-phenylenediamine type, may cause sensitization dermatitis on the operator as well as on the subject.

Protective Measures.—Occupational hazards can be avoided in the operator's case by the wearing of a clean pair of rubber gloves and impervious sleeves each time a hair treatment is given. Gloves made of thin rubber, such as surgeons gloves, do not hamper the operator's dexterity. Impervious sleeves protect the arms. The practice of wearing fresh gloves and sleeves for each person is sanitary and not unduly expensive. When sleeves and gloves are taken off they may be disinfected by immersion in a germicidal solution such as 1 per cent of Liquor Cresolis Compositus for not less than ten minutes and subsequent rinsing and drying. Impervious aprons protect the front of the body of the operator from accidental splashes of irritants. The sleeves and gloves made of transparent or translucent plastics, such as cellulose acetate, pliofilm, vinylite, etc., impart a clean and neat appearance to the operator.

In addition to such clothing, operators with dry or delicate skin may use superfatted sulphonated oils instead of soaps for cleansing the hands. Before retiring they should apply a good emollient cream containing lanolin, or an animal or vegetable oil, and wear cotton gloves while sleeping. Manicurists are exposed to the action of alkalis used as cuticle softeners, to the solvents used in nail polish and nail polish removers, as well as to the resins and dyes contained in the nail polish. The alkalis and solvents have a direct action on the skin, but the resins and dyes may act as sensitizers producing allergic dermatitis. The preventive measures recommended for hairdressers also apply to manicurists.

FACE CREAMS

Finkenrath reported a case of dermatitis from "Po-Ho" cream. In Journal American Medical Association it is stated that any one of the ingredients of a "skin food cream" may be the cause of allergic dermatitis: lanolin, spermaceti, petrolatum and perfume oils.

Bartleman and Dukes reported a case of lead poisoning in an actress who had used grease paint containing 40 per cent white lead

Hollander reported a case of dermatitis caused by hypersensitivity to petrolatum.

Hoffman and Peters reported a case of dermatitis caused by a synthetic perfume methylheptine carbonate in a face cream

Curtis and Netherton reported 2 cases of dermatitis caused by hypersensitivity to triethanolamine in a face cream

Finnerud and Tobin reported a case of slate-gray pigmentation of face and neck in a patient using a freckle cream containing ammoniated mercury

Bleaching and freckle creams usually depend for their effect on peeling the superficial layers of the epithelium and mechanically removing cells containing pigment. When chemicals such as mercury lactic acid potassium hydroxide resorcinol and salicylic acid are used they may cause dermatitis.

Cold creams consist essentially of a mixture of fats waxes oils borax, water and perfume. They rarely cause dermatitis although lanolin beeswax and perfume may sensitize the skin.

Cleansing creams usually consist of an emulsion of mineral oils with the partially saponified beeswax acting as the dispersing agent. They are sometimes enriched by the addition of vegetable oil lanolin or one of the so-called absorption bases. These last are combinations of "lanolin concentrates" with an inert vehicle Other ingredients may be present since there has been introduced recently a host of synthetic or semi-synthetic materials. Many of the creams contain a preservative. Dermatitis resulting from a cleansing cream is usually due to the perfume or less frequently to any other of the oil-phase ingredients or emulsifying agents.

Hand creams are mostly stearate compounds. Similar in composition to the vanishing creams.

The hand creams and lotions are emulsions which may contain among other things in the dispersed phase cocoa butter or other vegetable fats, lanolin waxes and benzoin. The aqueous phase may contain glycerine, one of the glycols and varying proportions of alcohol. Vegetable gums (karaya trag. anth) mucilages (quince seed) or synthetic thickeners (methyl cellulose) are added to enhance the viscosity and to achieve a better stability of the emulsion. Emulsification may be achieved by any of the means referred to before

Dermatitis does not occur frequently from the use of hand creams, but one of the creams on the market has been responsible for one case and gum karaya for another

Lubricating or emollient creams are mixtures of animal vegetable and mineral oils to which preservative or anti-oxidants must be added to prevent rancidity or other forms of deterioration. These preservatives may cause dermatitis. Cases of allergic dermatitis have been reported from the other ingredients also although rarely when the numbers of users are taken into consideration.

Vanishing and foundation creams are essentially dispersions of stearic acid in the stearates of sodium potassium ammonium or

aliphatic amino derivatives. They may also contain one or more polyhydric alcohols (glycerine propylene glycol sorbitol etc.) vegetable or mineral fats (cocoa butter mineral oil) lanolin cetyl alcohol and some of the newer synthetic esters (*e g* glyceryl-monostearate)

Dermatitis is rare from vanishing creams. If it should occur it would most likely be due to the perfume or to the alkalinity of the cream in the latter case the skin in question might be susceptible also to the action of soap and water

Deodorants occur in the form of liquids creams (pastes) and powders. *Deodorant creams* without perspiration inhibitors consist essentially of fat benzoic acid and zinc peroxide irritation from them would be rare and caused by sensitivity to the fat or benzoic acid

The Journal of the American Medical Association says that some liquid perspiration inhibitors now on the market may cause dermatitis in sensitive skins due to a rather high concentration of the aluminum salts contained in them

The astringents used are aluminum chloride aluminum sulphate and phenolsulphonate formaldehyde, zinc salicylate and sulphocarbolate (phenolsulphonate) tannic acid and the tannates

Dermatitis may result from both liquid and cream deodorants. Hexamethylene *tetramine sometimes used in deodorants is a well-*known irritant and sensitizer It may decompose in perspiration liberating formaldehyde which in turn may be converted into formic acid The aluminum salts hydrolyze with formation of free acid the aluminum ion is assumed to combine with the protein of the skin and to act as a coagulant There is some risk in applying aluminum salts on the axilla or in the pubic region directly after shaving They also have a destructive action on fabrics, particularly at ironing temperatures unless used in combination with suitable buffering agents *e g* urea.

Dermatitis caused by deodorants is usually located in the axillae It may take the form of a simple sharply limited erythematous vesicular eruption or it may be a folliculitis. It may be confused with the dress shield dermatitis but patch tests with the deodorant and the dress shield will determine the etiology The unbuffered *liquid astringent deodorants are usually at fault the perspiration* inhibiting creams are the next likely offenders. The direct cause resides in the acidity of these preparations.

DEPILATORIES

The fashion of wearing transparent hosiery and abbreviated sports clothes has greatly increased the public demand for depilatories since the desire of every woman is to have superfluous hair removed The use of roentgen-rays for the purpose is extremely dangerous and the method should never be employed Electrolysis if skilfully performed is a safe and effective method for per

manent removal of hair but it is tedious and expensive. Commercial depilatories are therefore often resorted to although their effect is only temporary These preparations contain some ingredients that are capable of causing dermatitis.

Thallium, formerly a constituent of some depilatories was extremely harmful It removed the hair by systemic poisoning which resulted from absorption through the skin The substance was the active principle in an advertised hair remover which caused severe constitutional symptoms in many of its users.

Most of the other hair removers contain alkaline sulphides which dissolve keratin. While destroying the hair they may also act upon the outer layer of the skin and produce severe dermatitis. Other ingredients that may be harmful are calcium strontium potassium and sodium sulphide A mixture of mercaptan-carboxylic acid or one of its homologues is also used in hair removers

Depilatories are sometimes made of wax, which is melted and allowed to harden on the skin When it is pulled off it tears the hairs out, but these grow back again as usual. The melted wax and trauma of epilation may cause irritation on some skins.

Calcium thioglycolate in an alkaline medium is used in a number of the newer depilatories. Dermatitis appears to be less frequent than from the other sulphide depilatories. Calcium thioglycolate does not have the typical disagreeable hydrogen sulphide odor of the sulphides, but it does not act as rapidly Depilatories are perfumed to hide the unpleasant odor

LIPSTICK

Lipstick consists chiefly of castor oil cocoa butter beeswax, fat coloring matter and perfume. If an aniline dye is present it may cause irritation when the skin is broken The so-called indelible lipsticks are customarily colored with eosin a bromo-acid dye which is a photosensitizer Dermatitis of the lips (cheilitis) from lipstick occurs occasionally Case reports have shown either the perfume or the dye to be the cause in most instances.

Baer in 1935 reported cheilitis caused by a synthetic ingredient of a rose perfume methyl heptine carbonate, contained in a lipstick.

Sezary Horowitz and Grenet in 1935 reported a case of cheilitis from a lipstick caused by the dye tolu-safranin and another one caused by eosin. They doubted whether photosensitization played a part in the latter case but thought that lanolin in the lipstick intensified the irritant action of the eosin probably by carrying the dye deeper into the skin

Hellier reported a case of cheilitis caused by eosin and suggested that eosin acted as a photosensitizer

Flandin *et al* reported a case of cheilitis due to eosin and perfume in the lipstick carmine was well borne

Sulzberger and Goodman reported testing the lips of 12 patients having cheilitis and 2 having dermatitis of the face with the in-

gredients of the lipsticks. Eight of them were hypersensitive to bromofluorescein 7 to sulfobetanaphthalene azobetanaphthol. Six of the patients were provided with lipsticks that caused no trouble. They stated that lipstick dermatitis is rare and that it is based on acquired allergic hypersensitivity

Peck reported a case of cheilitis in which the site of a negative patch test became positive after ultra-violet irradiation.

Baer reported that he sensitized 9 patients out of 30 to a lipstick dye by 8 to 11 applications twice daily

Feiler reported a case of cheilitis in which the patient gave positive patch tests to a particular perfume lipstick and nail polish and negative patch tests to other dyes rouges and nail polishes.

Hecht *et al.* reported cheilitis, fixed eruption and gastro-intestinal allergy from eosin in a lipstick.

Hathaway reported 2 cases of dermatitis caused only by lipsticks which come in metal containers. He infers that the metal which somehow contaminated the lipstick was the actual cause.

ROUGE

Except for the coloring matter which is frequently an aniline dye—and possibly the perfume—the ingredients of these cosmetics are relatively innocuous. Rouge is generally composed of talc, titanium or zinc oxide starch coloring matter and a binder of acacia or tragacanth

NAIL PREPARATIONS

Cuticle removers generally consist of a solution of potassium hydroxide triethanolamine or other powerful alkalis. Salicylic and oxalic acids may also be present. In high concentrations these substances are capable of destroying the finger nails as well as the excess cuticle

Liquid nail polish is made of a synthetic resin in a solution of acetone or amyl acetate with a plasticizer and dye added Dermatitis *of the face and other parts of the body accessible to the* hands has been frequently reported as having been caused by nail lacquers. The solvents tend to cause dryness and splitting of the nails.

Liquid polish removers consist chiefly of acetone which may cause smarting redness and inflammation after prolonged contact with the skin.

Pardo-Castello says that brittleness of the nails is caused by excessive manicuring The constant use of colored enamels and of ethyl acetate and acetone solvents to remove the enamel produces excessive dryness. Cuticle removers consisting of strong alkalis are contributing factors

Sulzberger in 1937 first called attention to dermatitis from hyper

sensitivity to nail polish. In 1940 he again reported a case of dermatitis of the face and chest caused by nail polish

Dryness and cracking of the nails is caused by the fat solvents in nail polishes and nail polish removers according to a recent report in the Journal of the American Medical Association

Hollander reported 3 cases of dermatitis of the face due to contact with nail polish In these cases he noted that the hands were not affected and patch tests with the offending lacquer were negative.

Burgess reported 10 cases of dermatitis of the face and neck caused by nail polish. Patch tests with the particular nail polish were positive in every instance and removal of the nail polish effected a cure.

Shellow reported a case of discoloration of the nails due to nail enamel

Silver and Chiego after an intensive study state that in various diseases brittleness of the nails is quite common, that soap and water are important contributing causes that the iron metabolism plays an important rôle and that the nail lacquer solvents have a dehydrating rather than a defatting effect on the nails because the nails normally contain but little fat.

Ellis and Kirby-Smith reported 5 cases of dermatitis of the face and neck in which they performed patch tests with the ingredients of a particular nail polish, namely castor oil camphor dibutyl phthalate clear lacquer titanium oxide and several dyes. They obtained positive reactions to camphor clear lacquer and to one of the dyes in some of the cases whereas in others, only the complete nail lacquer yielded positive reactions.

They obtained negative reactions to the volatile solvents because the small amounts used on gauze for patch testing soon evaporate or spread over larger areas of skin and are not sufficient to affect the skin. (Author's comment.)

Goldberg reported cases which he attributed to toluol used as a solvent, because patch tests with 10 to 20 per cent of toluol were positive (The solvent in nail polish evaporates as the polish dries and therefore cannot affect the face. It can only affect the nails and surrounding skin) (Author's note.)

In a series of tests performed by the authors, it was found that usually the resins and rarely the dyes were responsible for most cases of nail polish dermatitis.

Feiler reported a case of dermatitis caused by a so-called "non-allergic" nail polish and lipstick.

Holtzman reported 2 cases of dermatitis from nail lacquer and stated that the ester gum in the lacquer was the probable irritant.

Palmer reported 9 cases of nail lacquer dermatitis. Patch tests with the dyes were negative but 8 out of the 9 reacted to the colorless lacquer He believes that the synthetic resins or glycol ethers were the chief irritants.

Shellow reported a case of generalized dermatitis from nail polish.

Osborne *et al* believe that the sensitizing agent in nail lacquer

usually is the resin or plasticiser less frequently the cellulose nitrate and seldom the pigment.

Garbe reported a case of dermatitis in a man from transparent polish

Semon reported a case of dermatitis from colorless nail polish.

Simon reports performing patch tests on 7 cases of nail polish dermatitis with 25 chemicals commonly used in making nail polish all of them reacted to only one chemical, a sulfonamide-formaldehyde resin. Controls showed no reaction Therefore he concluded that this resin is the chief allergen in nail lacquer

Guy and Jacob reported 25 cases of nail polish dermatitis proved by patch tests. The products of seven manufacturers were tested and both colored and clear polishes were at fault

Dobes and Nappert reported 90 cases of dermatitis from nail polish. They patch tested 30 of these with various ingredients contained in nail polish and found some who were sensitive to the dyes some to the resin some to nitrocellulose and some to the solvents. They conclude that a brand can usually be found to which the patient is not sensitive.

Madden reported a case so sensitive to nail polish that dermatitis developed as a result of sleeping with a friend who wore it.

Frootko discussed relapsing dermatitis and pruritis vulvæ from nail polish

Dermatitis from nail polish may appear on any part of the body accessible to the nails the face neck, chest, the regions around the arms and the vulva The lesions disappear with mild palliative treatment when the use of nail polish is discontinued Sometimes different brands of nail polish can be tried in an effort to find one which does not contain the sensitizing chemical. The latter may be ascertained by patch tests with the ingredients in the dried nail lacquer performed as follows Dissolve separately each ingredient of the nail lacquer in the solvent Wet a piece of gauze with the solution and allow to dry Apply the dried gauze patches to the skin and allow to remain for forty-eight hours. Do not patch test with the solvent (If the solvents are volatile they will not remain on the patch long enough to cause a reaction. If they are not volatile enough to evaporate from gauze they will cause dermatitis because of their fat solvent action) If the actual sensitizing chemical is found an effort can be made to use nail polish which does not contain it Sometimes patch tests must be performed with combinations of the chemicals before reactions are obtained

COSMETIC POWDERS

At the present time most of the face and body powders made and marketed by reputable firms are practically harmless being composed for the most part of talc zinc oxide, zinc stearate precipitated chalk, kaolin titanium dioxide and rice starch. Bismuth subnitrate may cause irritation of the skin and dermatitis due to the perfumes in face powder has been reported

Colors are added to obtain the different powder shades The colors may be aluminum calcium barium or other metal lakes of aniline dyes. These are also used—the oxides of iron ochres umbers, etc., or mixtures of these

Compact powders contain the same ingredients as loose powders pressed or molded into cakes by the use of a binder such as tragacanth

Liquid powders contain inert substances suspended in water and alcohol Usually a dispersing agent is present to make the powder adhere to the skin

Dermatitis from face powders is rare Allergic dermatitis has been reported from orris root starch (which is rarely used in the modern cosmetics) and to the perfume.

Many of the above ingredients although harmless to the consumer are potential irritants to industrial workers who handle large quantities of the raw materials.

Schmitter stated that cosmetic powders may be the source of allergic irritation and carriers of respiratory disease

Certain ingredients of cosmetic powders are more or less allergenic Among them are white lead bismuth mercury and zinc compounds calcium carbonate calcium and barium sulphate Also aniline dyes, orris root and certain perfume ingredients as well as heliotrope

Hollander reported a case of dermatitis traced to a face powder conveyor made of rubber

Murray reported a case of chromidrosis caused by the dye in a face powder Dyeing of the hair also has been seen as a result of contact with powder containing soluble dyes

Ellis reports a case of dermatitis of the leg caused by F D & C yellow No 3 in a leg makeup this dye is 1 phenylazo-2-naphthyl amine

PERFUMES

Cases of dermatitis among workers manufacturing perfumes have been reported Schwartz described an outbreak among girls bottling perfumes. He found that linalool a terpene alcohol present in many of the essential oils was the offending chemical Sensitivity to linalool was acquired after working with it for about one month.

Most of the essential oils will irritate the skin if allowed to remain on in high concentration for a few hours. The oils contained in perfumes may be divided into three groups according to their origin (1) Vegetable (2) animal and (3) synthetic Many of the odors of the perfumes in Group 1 can be simulated by those in Group 3 *e g* the odor of violet and jasmine is synthetically produced by the use of methyl-heptine-carbonate

Vegetable Oils —The essential oils of this group used in perfumery are obtained from the following sources

Cassia flowers and bark	Pine wood
Carnation, flowers	Lignaloe wood
Clove flowers	Sandal wood

Hyacinth flowers	Angelica roots
Heliotrope, flowers	Sassafras roots
Mimosa, flowers	Vetivert roots
Jasmine, flowers	Bergamot fruit
Jonquil, flowers	Caraway fruit
Orange, flowers and fruit	Lemon fruit
Rose flowers	Lime fruit
Reseda, flowers	Bitter almond seeds
Violet, flowers and leaves	Anise seeds
Ylang ylang, flowers	Fennel seeds
Lavender flowers and leaves	Nutmeg seeds
Rosemary flowers and leaves	Ginger rhizomes
Peppermint, flowers and leaves	Orris rhizomes
Geranium, leaves and stem	Calamus rhizomes
Patchouli, leaves and stems	Thyme
Petitgrain leaves and stems	Vanilla
Verbena leaves and stems	Kananga
Cinnamon, leaves, stems and bark	Canada snake root
Citronella grass	Storax balsam
Canella bark	Tolu balsam
Cedar wood	Melissa

These essential oils are of complex composition and contain alcohols, terpenes aldehydes esters ketones phenols acids anhydrides, nitrogenous substances and hydrocarbons.

Perfumes are made by the following processes

1 Distillation of flowers roots leaves *e g* attar of roses.

2. Expressing *e g* citrus oils pressed from the rinds and flowers.

3 Extraction by means of solvents such as alcohol chloroform carbon bisulphide etc.

4 Maceration with solid and liquid fats.

The perfumes are usually blended before they are sold to the public and dermatitis among the handlers may occur in sensitive workers during this process. The factory employees most exposed are those who express the oils especially from citrus fruits and those engaged in blending and bottling the product

Animal Oils.—Perfumes of animal origin are derived from the following sources

Ambergris a grayish substance with a penetrating and disagreeable odor which comes from the intestines of the sperm whale.

Musk a secretion from the preputial sac of the musk deer

Civet a yellowish substance having a strong musk-like odor which is found in a pouch near the genitalia of the civet cat.

Castor a brownish strong-smelling substance from the preputial follicles of the beaver

Many of these are now produced artificially

Experimentation and clinical experience have shown that the essential oil of bergamot is the chief agent in the production of perfume dermatitis

A typical form of the lesion for which the oil is only partly responsible is seen in Berlocque dermatitis This manifests itself by pigmentation of the skin upon exposure to sunlight following the application of perfume It is characterized by dark yellowish

streaks occurring on the area of skin to which the perfume has been applied which is usually the neck. The upper portions of the streaks are hardly visible, but the color deepens towards the bottom giving the appearance of a dark fluid running downward. The magnifying glass reveals signs of inflammation in the pigmented area with dilatation of the capillaries and prominence of the openings of the hair follicles. The factors necessary to its production appear to be (1) Application of perfume containing oil of bergamot (2) exposure of the part to natural sunlight (experiments with ultra-violet rays have given negative results) and (3) sensitivity of the individual.

As early as 1916 Freund reported a number of cases of Berlocque dermatitis of the neck, due to the application of toilet water followed immediately by exposure to sunlight. Experimentation convinced him that the essential oil of bergamot was the responsible agent and his findings have since been amply confirmed by others.

The nature of the photosensitizing agent in bergamot oil is not known. It has been suggested that individual hypersensitivity to chlorophyll or adulterants in the perfume may cause the dermatitis. Goodman believes it possible that copper which is sometimes present in the higher-priced perfumes plays a part in the pigmentation of the skin. The best grades of oil of bergamot are packed and shipped in copper containers, and it is the most expensive perfumes that most often cause the dermatitis.

Berlocque dermatitis is reported from all parts of the world where women (or men) use perfumery or cosmetics containing it and expose themselves soon afterwards to sunshine. Due to increasing enthusiasm for sun bathing and the increasing use of perfumed alcoholic lotions etc. cases of Berlocque dermatitis appear to be growing more frequent.

Dermatitis among users of perfumes is of comparatively frequent occurrence and has often been reported. Tobias describes the case of a woman who sustained a severe vesicular eruption on the left shoulder after having sprayed her dress in that region with a certain perfume every evening for six months. Sensitivity was gradually developed by its regular application. After a positive patch test the perfume was discarded and the eruption cleared up within five days.

Babalian reports the case of a young man who developed an acute dermatitis of the face after visiting a friend who perfumed herself with powdered orris root.

Dermatitis due to perfume containing oil of hyacinth a synthetic product made in the Netherlands, has recently been reported.

Numerous cases appear in the literature in which methyl heptine carbonate ($C_6H_{13}CHO$) has been found responsible for dermatitis when applied directly to the skin as a perfume or as an ingredient in lipstick or other cosmetics having a violet or jasmine fragrance.

Feller reported a case of dermatitis in which the patient was sensitive to a brand of so-called hypo-allergic perfume.

It is difficult to determine all the ingredients of a particular prepared perfume which may be causing dermatitis or asthma and to perform patch tests with all of them to find the actual allergen It is necessary in such cases to trace the perfume to its blender and obtain from him all the ingredients. Such a procedure is long arduous and time-consuming and has not often been done

The following ingredients of perfumes have been reported to have been the actual causes of dermatitis

Oil of cloves	Hydroxy-citronellal
Oil of bergamot	Heliotropin
Oil of cinnamon	Limonene
Oil of lemon	Linalool
Oil of orange	Pinene
Oil of cassia	Olibanum resin
Oil of angelica root	Vanillin
Eugenol	Nitro-benzene
Iso-eugenol	Methyl heptine carbonate
Citral	

In patch testing with perfumes, it is better to use uncovered patches so as to avoid the possible defatting action of the solvent which would complicate the reaction

HAIR PREPARATIONS

Hair Dyes.—Dermatitis from hair dyes was reported more frequently with the introduction of paraphenylenediamine These dyes are often referred to as aniline dyes. They are more correctly designated as oxidation coal tar dyes Most of the hair dyes on the market today may be divided into the following groups (1) Vegetable colors (2) metallic salt dyes (3) compound dyes and (4) synthetic organic dyes.

The vegetable dyes are natural dyes derived from plants and woods. They have a definite chemical composition and some have been made synthetically

Vegetable dyes are ordinarily harmless in their pure form but since their action is usually temporary and their range of tones narrow they are employed very little commercially Rhubarb root whose active principle is chrysophanic acid is used for blond hair as are the natural leaves of indigo camomile flowers the green husks of nuts yielding tannin and orlean the dye from Bixa orellana. Nut galls, whose active principle is tannic acid campeachywood and solutions of peat or extracts of peat with ammonia are also used for dyeing hair Henna is derived from the dried and powdered leaves of Lawsonia inermis or Egyptian privet which grows in Africa Judea and Arabia. Its active principle is a red dye alkanna Unfortunately it is seldom obtained in its pure form but many synthetic preparations are sold under the name of henna because of its good reputation

The metallic salt dyes act by forming a chemical combination with the sulphur of the hair forming a sulphide or by being reduced to the

metal or a lower oxidation stage by the action of the hair protein They are deposited as a coating on the hair shaft. Their continuous use may cause the hair to become brittle

Lead salts are the oldest of the metallic "dyes" They must be applied repeatedly to the hair and are known as progressive dyes. There is no danger of lead poisoning from the use of lead hair dyes because inorganic lead salts are not absorbed by the skin. Dermatitis from lead hair dyes has not been reported.

Silver nitrate has been widely used as a hair dye. It darkens when exposed to light or when used with a developer such as pyrogallol or sodium thiosulphate. Argyria and dermatitis is a possibility from its prolonged use

Copper cadmium tin, nickel bismuth, cobalt and iron salts may be used but have rarely been used as hair dyes.

Pyrogallic acid may be used in conjunction with the metallic salts to obtain a more rapid action Pyrogallic acid itself or in combination with an alkali is a hair dye

Compound dyes are made by mixing vegetable colors with metallic salts They are made into a "pack" and are applied to the hair followed by a solution of sodium perborate or hydrogen peroxide

The Synthetic Organic Hair Dyes.—Almost any synthetic dye may irritate some skins. The most commonly used dye of this class is paraphenylenediamine. It is usually sold in two bottles, one of them contains a 1 to 3 per cent aqueous solution of paraphenylenediamine and the other may contain hydrogen peroxide sodium perborate potassium dichromate or sodium persulphate Potassium dichromate is a powerful sensitizer

Instead of the paraphenylenediamine, paraminophenol para methyl aminophenol sulphate (metol) and paraminophenol hydrochloride (rodinol) can be used.

Dermatitis from paraphenylenediamine hair dye may involve the scalp forehead face, ears, eyes, and it may become generalized. (Figs. 36 and 37.) The eyes must be watched for signs of corneal involvement which occurs in some cases of severe conjunctivitis.

Ingram stated that 4 per cent of the general population have an idiosyncrasy to paraphenylenediamine. This estimate is too high.

Close Goodman and Baba have reported systemic poisoning from paraphenylenediamine

Numerous instances of eye injuries have been reported following the use of this dye by Greenbourn Forbes and Blake Aust Bab and many others.

Reports of dermatitis from the use of paraphenylenediamine as a hair dye as can be seen from the bibliography are too numerous to mention individually

The same irritating ingredients found in hair dyes are also employed in dyes for the eyelashes and eyebrows where they are even more dangerous to the delicate tissues around the eyes.

Occupational dermatitis among hairdressers from organic hair dyes was reported by Berger

FIG. 36.—Occupational dermatitis in hairdresser due to paraphenylenediamine Positive patch test. (Case of Dr F P Lowenfish Vanderbilt Clinic, Columbia University New York)

FIG. 37—Dermatitis of face resulting from application of hair dye containing paraphenylenediamine Patch test with hair dye on left forearm followed the next day by generalized dermatitis. (Case of Dr Howard Fox)

In treating less severe forms of dermatitis from paraphenylenediamine hair dyes, the hair should be throughly shampooed with soap and water to remove all excess dye. This should be followed by a thorough rinsing with hydrogen peroxide solution in order to oxidize the dye to the final harmless oxidation stage (Bandrowski s base) The peroxide should be removed with a soap shampoo and the dermatitis treated by wet dressings of boric acid or Burow's solution The eyes if affected should also be treated If the symptoms do not rapidly abate it may be necessary to shave the scalp

The diagnosis of hair dye dermatitis is made from the history of having used the dye before the onset of the dermatitis, and by obtaining positive patch tests with the dye solution either singly or in combination if it is a two or more bottle dye.

Hair Bleaches.—Hair bleaches usually consist of an alkaline solution of hydrogen peroxide or sodium perborate Bleaching pastes contain the same ingredients as solutions. However the alkali used may be magnesium or sodium carbonate

Bleaching if frequently repeated tends to make the hair dry and brittle.

Hair Tonics and Lotions.—Hair tonics have also been found responsible for dermatitis although far less so than dyes.

Hair tonics usually contain a rubefacient, an antiseptic an oil and perfumed alcohol. Quinine, hydroxyquinoline resorcinol, mercuric chloride and betanaphthol are commonly used antiseptics. Extract of capsicum balsam of Peru, salicylic acid and extract of cantharides are the most common rubefacients. Castor oil and liquid paraffine are the usual oils. A tar such as liquor carbonis detergens is also used in some preparations.

Dermatitis from hair tonics and dandruff removers is not uncommon Resorcinol, betanaphthol salicylic acid capsicum and cantharides are primary skin irritants when used in strong concentrations they can act as sensitizers when used in dilute solutions. Allergy to quinine is also not rare.

Dermatitis from hair tonics may involve the scalp neck forehead ears, and the upper part of the face especially the eyelids. It may be acute vesicular or of the chronic, dry scaly type.

The history and site of the lesions make the diagnosis easy Usage tests performed with the proper dilutions of each ingredient will reveal the actual irritant. The treatment is symptomatic and the prevention consists in avoiding the use of the irritant.

Hair Wavers.—A 'water wave consists of wetting stretching and curling the hair and then allowing it to dry while stretched The curl thus obtained will be retained for sometime.

If an alkaline substance is dissolved in the water with which the hair is wetted it softens the keratin If the hair is then heated stretched curled and dried the curl is retained for a longer time resulting in what is called a "permanent wave"

The alkaline solution may contain chemicals such as ammonia triethanolamine monoethanolamine or 1-4 tetrahydroxy-oxirene

The alkalis may cause burns. Burns may also result from poorly insulated electric wires and from heating pads.

Cold waving solutions consist of chemicals to soften the hair and gums or resins to hold or set the curl.

Alkalis are usually employed to soften the hair. Recently thioglycolates have been introduced for this purpose. The setting agents may be gum karaya, sodium alginate, soluble shellac, etc. The thioglycolate solution is first applied to soften the hair (reduce it) and the wave is set by applying an oxidizing agent such as a peroxide.

Dermatitis may result from the primary irritant effects of the alkaline substances or an allergic contact dermatitis may occur from the resins or both.

Hair Straighteners.—A gum solution or a perfumed petroleum jelly may be used, or hair straighteners may consist of strongly alkaline chemicals such as sodium hydroxide. Dermatitis may occur due to the alkalinity of the materials used. In some instances sensitization dermatitis has resulted from the perfume.

Hair Lacquers.—These are used to hold the hair in place. They consist of solutions of colloidal materials such as gum resins in a solvent. When the solvent evaporates, the resin remains and acts as a glue to hold the hair in the desired shape.

The aqueous solutions are alkaline and may cause dermatitis to hairdressers and users. Recently an outbreak of dermatitis occurred among users of hair lacquer pads which were impregnated with a strongly alkaline solution of a synthetic resin derived from maleic anhydride.

SUNTAN PREPARATIONS

Light rays of shorter wave lengths than 4,100 Å (Angstrom units) are the cause of sunburn and suntan. Since wave lengths from 2,500 to 3,200 Å cause solar erythema, an ideal suntan preparation would be one which filtered out all the rays shorter than 3,200 Angstroms and allowed the longer ones to pass. Thus there should be tanning with a minimum of erythema.

There are many organic chemicals with suitable absorption characteristics. Listed below are some of the chemicals used:

Menthyl salicylate	Menthyl antheranilate
Esculin	Menthyl umbelliferone
Esculetin	Di-benzylacetone
Methyl esculetin	Isobutyl-p-aminobenzoate
Menthyl benzoate	p-Hydroxynaphthoic acid
Phenyl coumarine	Naphthol-sulphonic acids
Phenyl indole	Benzalacetophenone
Quinine salts	Isosafrole

Salol and quinine are seldom used because of their known sensitizing properties. Dermatitis from suntan preparations has rarely been reported.

CHEMICALS IN COSMETICS WHICH MAY CAUSE IRRITATION

Dermatitis may result from the primary irritant effect of a chemical or from an induced hypersensitivity or allergy to it. Most of the cases of dermatitis from cosmetics are due to an acquired hypersensitivity. The chemicals causing an allergic contact dermatitis are referred to as sensitizers. (See Chapter XLVII.)

There is listed below only some of the chemicals used in cosmetics which may cause dermatitis either by sensitization or by primary irritant action or both.

Substance	Use	Mode of action on skin	
Acacia	Emulsions, hair preparations	Sensitizer	
Acetic acid			Primary irritant
Acetone	Nail lacquers		Primary irritant
Aldehydes	Perfumes	Sensitizer	
Alkanna	Dyes	Sensitizer	
Alkyd resins	Nail lacquers	Sensitizer	
Aluminum sulphat	Anti-perspirant		Primary irritant
Aluminum chloride	Anti-perspirant		Primary irritant
Amidol	Hair dye	Sensitizer	
Ammonia	Hair waves and bleaches		Primary irritant
Ammoniated mercury	Freckle creams	Sensitizer	Primary irritant
Ammonium bisulphite	Hair waves and bleaches		Primary irritant
Ammonium carbonat	Hair waves and bleaches		Primary irritant
Ammonium sulphide	Depilatory		Primary irritant
Amyl acetate	Nail lacquer		Primary irritant
Amyl metacresol	Preservative	Sensitizer	Primary irritant
Angelica oil	Perfumes	Sensitizer	
Anti-oxidants		Sensitizer	
Antiseptics		Sensitizer	Primary irritant
Arnica flowers	Perfumes	Sensitizer	
Balm of Gilead		Sensitizer	
Bayberry	Hair tonics	Sensitizer	
Bay oil	Hair tonics	Sensitizer	
Beeswax	Nail polish and creams, lotions	Sensitizer	
Bay Rum	Hair tonic	Sensitizer	
Benzoic acid	Creams	Sensitizer	
Benzoin	Creams	Sensitizer	
Benzoyl peroxide	Bleach	Sensitizer	
Benzyl benzoate	Perfume fixative	Sensitizer	
Bergamot oil	Perfume	Sensitizer	
Beta-naphthol	Hair tonic	Sensitizer	Primary irritant
Boric acid	Dusting powders	Sensitizer	
Brazil wood	Dye	Sensitizer	
Bromo acid	Lipstick	Sensitizer	
Cadmium hydrosulphide	Depilatory		Primary irritant
Calcium sulphide	Depilatory		Primary irritant
Calcium thioglycolat	Depilatory		Primary irritant
Canada balsam	Perfumes	Sensitizer	
Cantharides	Hair tonic	Sensitizer	Primary irritant
Carbolic acid	Preservative	Sensitizer	Primary irritant
Carvacrol	Antiseptic	Sensitizer	Primary irritant
Cassia oil	Perfumes	Sensitizer	
Cedarwood oil	Perfumes	Sensitizer	
Chlorocarvacrol	Preservative	Sensitizer	Primary irritant
Chlorothymol	Preservative	Sensitizer	Primary irritant
Citral	Perfume	Sensitizer	
Citronella oil	Perfume, insect repellent	Sensitizer	Primary irritant
Clove oil (eugenol)	Perfume	Sensitizer	
Cocoanut oil	Shampoo	Sensitizer	

Substance	Use	Mode of action on skin	
Cresol	Preservative	Sensitiser	Primary irritant
Cyclohexanol	Solvent		Primary irritant
Diethyl phthalate	Perfumes	Sensitiser	
Dyes		Sensitiser	
Essential oils	Perfumes	Sensitiser	Primary irritant
Ethanolamines	Hair wavers	Sensitiser	Primary irritant
Ethyl acetate	Nail lacquers	Sensitiser	Primary irritant
Ethylene diamine	Hair wavers		Primary irritant
Eucalyptus oil	Flavor, dental	Sensitiser	
Eugenol	Perfume	Sensitiser	
Formaldehyde	Preservative		Primary irritant
Geranium	Perfume	Sensitiser	
Hair dyes		Sensitiser	
Hair lacquers		Sensitiser	
Hair lotions		Sensitiser	
Hair wavers		Sensitiser	Primary irritant
Hyacinth oil	Perfume	Sensitiser	
Jasmine oil	Perfume	Sensitiser	
Jonquil oil	Perfume	Sensitiser	
Karaya gum	Hair preparation	Sensitiser	
Lanolin	Creams	Sensitiser	
Lavender oil	Perfumes	Sensitiser	
Lemon oil	Perfumes	Sensitiser	
Lime oil	Perfumes	Sensitiser	Primary irritant
Lemongrass	Perfumes	Sensitiser	Primary irritant
Linalool	Perfumes	Sensitiser	
Linseed oil	Shampoos	Sensitiser	
Maleic acid	Hair wavers	Sensitiser	
Mercuric compounds	Preservatives	Sensitiser	Primary irritant
Methacrylate resins	Nail lacquers	Sensitiser	
Methenamine	Deodorants	Sensitiser	
Methyl heptine carbonate	Perfumes	Sensitiser	
Morpholine	Hair wavers	Sensitiser	Primary irritant
Nail bleaches			Primary irritant
Nail lacquers		Sensitiser	
Neroli oil	Perfume	Sensitiser	
Oleic acid	Creams	Sensitiser	
Olibanum	Perfumes	Sensitiser	
Orange oil	Perfumes	Sensitiser	
Orris oil	Perfumes	Sensitiser	
Orris root	Face powders	Sensitiser	
Orthophenylphenol	Preservative	Sensitiser	Primary irritant
Oxalic acid	Bleach		Primary irritant
Paraphenylene diamine	Hair dye	Sensitiser	
Perfumes		Sensitiser	
Plants			
Primrose			
Lilac			
Nasturtium		Sensitiser	
Osage orange			
Red cedar			
Yellow jasmine			
Phenolic resins	Nail lacquers	Sensitiser	
Phenyl mercuric salt	Preservatives	Sensitiser	Primary irritant
Polyvinyl alcohol resins	Nail lacquers	Sensitiser	
Potassium bisulphite	Hair wavers and bleaches		Primary irritant
Potassium sulphide	Depilatories		Primary irritant
Plasticisers		Sensitiser	
Pyrogallic acid	Hair dye	Sensitiser	
Quinine salts	Suntan	Sensitiser	
Resins, natural	Creams, hair, nail	Sensitiser	
Resins, synthetic	Nail preparations	Sensitiser	
Resorcinol	Antiseptic, hair tonics	Sensitiser	Primary irritant
Salicylic acid	Preservative	Sensitiser	Primary irritant
Soaps	Cleansers	Sensitiser	
Sodium carbonate	Hair wavers		Primary irritant

Substance	Use	Mode of action on skin	
Sodium persulphat	Hair wavers	Sensitizer	
Sodium stannite	Hair wavers		Primary irritant
Sodium sulphide	Depilatory		Primary irritant
Solvents			Primary irritant
Sulphides	Depilatory		Primary irritant
Sulphites	Bleaches		Primary irritant
Tangerine oil	Perfumes	Sensitizer	
Terpenes	Perfumes	Sensitizer	
Terpineol	Perfumes	Sensitizer	
Thymol	Antiseptic		Primary irritant
Triethanol amine	Alkali		Primary irritant
Tuberose oil	Perfumes	Sensitizer	
Undecylic salts	Face powders	Sensitizer	
Vanilla	Perfumes	Sensitizer	
Wave lotions		Sensitizer	
Waxes	Creams	Sensitizer	
Zinc ammon. chloride	Hair wavers		Primary irritant
Zinc format	Anti-perspirant	Sensitizer	Primary irritant
Zinc salicylat	Anti-perspirant	Sensitizer	Primary irritant
Zinc sulphat	Anti-perspirant		Primary irritant

DIAGNOSIS OF COSMETIC DERMATITIS

Dermatitis may erroneously be attributed to cosmetics. In order to determine the etiology of a dermatitis suspected of being caused by a cosmetic, the following general criteria should be considered

1 The history of the dermatitis must show that it occurred after the suspected cosmetic began to be used

2. That the dermatitis first appeared on the part of the skin where the cosmetic was applied except in cases where the irritant is transferred to a more sensitive part of the skin as in the case of nail polish

3. In the large majority of cases, the dermatitis is confined to the part to which the cosmetic was applied

4 The appearance of the eruption is that of a contact dermatitis

5 Dermatitis of non-contact origin can be ruled out by a competent dermatologist.

6. Skin tests which have due regard for the irritant properties of the chemicals in the cosmetic made on normal portions of the skin or application of the cosmetic in a manner emulating that in which the cosmetic is actually used should show that the skin of the patient is irritated by the cosmetic. Patch test sites performed on covered parts of the body in cases of dermatitis on uncovered parts should be exposed to sunlight for two hours to determine the presence of a photosensitivity

7 When the use of the cosmetic is discontinued there should follow an improvement of the dermatitis

8. Re-use of the cosmetic after the dermatitis disappears or improves should result in a recurrence of the dermatitis

THE TREATMENT OF COSMETIC DERMATITIS

The treatment of the average case of cosmetic dermatitis is relatively simple since the eruption is of external origin. In most

instances the eruption is an allergic contact dermatitis which is acute or sub-acute less frequently it may have the character of a more chronic type of dermatitis.

The majority of patients with an allergic contact dermatitis, no matter what the cause may be, improve rapidly once contact with the causative agent is terminated Therefore one of the first steps in instituting treatment is to establish the etiology of the dermatitis and to insure that future contact with the causative agent by the patient is avoided It is not enough to make a broad etiologic diagnosis such as the demonstration that a face powder a cream or a lipstick was the cause of the dermatitis. In order to avoid a recurrence of the eruption unless we ban the whole class of the particular cosmetic involved the specific chemical causing the dermatitis in the face powder cream etc should be established Once this is done cosmetics can be used again provided they do not contain the chemical to which the patient is sensitive

There are a few basic principles to be followed in treatment A thorough knowledge of the proper use of a few simple topical remedies is much more valuable than a collection of many prescriptions most of which differ very little fundamentally from each other or are formulated for special purpose

Wet Dressings.—Wet dressings are indicated in the acute stages of the eruption Since in most instances we are not dealing with secondary infection cold rather than hot wet dressings should be used Hot wet dressings are indicated when secondary infection occurs It is inadvisable to use antiseptics since another dermatitis hazard may be added Simple types of wet dressings should be used

Sitz baths can be used for eruptions around the buttocks and genitalia When dermatitis covers large areas of the body soothing baths containing starch are often helpful Starch can also be used in sitz baths. The starch should be boiled before it is used

Lotions.—When the dermatitis is widespread or when the acute symptoms have subsided or in between wet dressings lotions are very helpful An unmedicated lotion is best for a cosmetic dermatitis. However menthol 0.5 per cent may be added for its cooling anti-pruritic effect

Ointments.—Except for the treatment of chronic changes it is the soothing and protective effects of the ointments which are the basis for their use in cosmetic dermatitis. Active medicaments such as tar sulphur and mercury which are used in the treatment of chronic eczematoid conditions of unknown etiology are not necessary and often add to the dermatitis already present It is best to use types of ointments which will absorb secretions if present

In our opinion in practically all cases of contact dermatitis once the irritant has been removed simple soothing treatment properly applied will clear up the dermatitis.

While it is agreed that x-ray expertly used may hasten recovery in chronic cases this agent should not be used as an alternative for tracing and removing the irritant causing the dermatitis

The use of soap for cleansing the part affected with dermatitis is contraindicated. Many patients with contact dermatitis have a superimposed irritation from soap Soap substitutes or oils should be used for cleansing

METHOD OF TESTING NEW COSMETICS

Before placing a changed formula or a new formula on the market closed patch tests should be performed by a competent dermatologist on at least 200 subjects with the new formula using as a control in the former case the old formula which had been on the market for years, and which caused no unusual number of complaints. The closed patches should remain on the skin for forty-eight hours after which the reactions should be read each day for three days in order to observe late reactions. The number of reactions obtained from the new formula should not exceed the number obtained from the old

Ten to eighteen days after the last reading of the reactions new closed patches of both new and old formulas should be reapplied on the same 200 subjects and allowed to remain on the skin for forty eight hours and the reactions again read each day for three days after removal of the patches If the number of subjects showing sensitization reactions from the new formula exceeds the number showing sensitization reactions from the old ones the new formula is unsafe. These tests will give an idea of the relative skin-irritating and sensitizing properties of the new formula as compared with the old one but they do not give an accurate idea of what may happen under conditions of actual use. Therefore, the following additional tests should be performed

The same 200 people should actually use the old and the new cosmetic each day on opposite sides of the body for a period of four weeks. No cases of dermatitis should result from the old cosmetic. If no cases of dermatitis result from the new formula, it is safe to place it on trial sale If more than one case of dermatitis develops, the product is probably unsafe If only one case of dermatitis results then another group of 200 people should be subjected to the actual use test, and if one or more cases of irritation occur in this group then the product should be discarded as unsafe If no cases occur in the second group of 200 then a trial sale as described below may be given the cosmetic, but it must always be borne in mind that other groups of 200 may reveal other cases of sensitivity which would show the product to be unsafe (See statistical table)

By trial sale is meant the sale for a period of not less than one month for cosmetics used daily and correspondingly longer periods for cosmetics used less frequently (if no cases of dermatitis are reported before this time) The sale should be in one community and between 5,000 to 10,000 packages of the cosmetic should be sold and time permitted to elapse for them to be used up by the purchasers. If no cases of dermatitis are reported during the trial

sale then the cosmetic may be put on the market always bearing in mind the probabilities as shown in the table

TABLE 10

No. subjects patch tested	Likely maximum percentage rate of positive reactions[a]: No reaction in sample	1 reaction in sample	2 reactions in sample
30,000	0.01		
20,000			0.03
10,000	0.03	0.05	0.06
5,000	0.06	0.09	
4,000			0.15
2,000	0.15	0.23	0.30
1,000	0.30	0.45	
800	0.37	0.56	0.75
600	0.50	0.75	1.00
500			1.20
400	0.75	1.10	1.50
300	0.99	1.50	2.00
250	1.20	1.80	2.40
200	1.50	2.20	2.90
160			3.70
150	2.00	3.00	
125	2.40	3.60	
120			4.90
100	3.00	4.40	5.80
80	3.70	5.50	7.20
60	4.90	7.20	9.60
50	5.80	8.80	
40	7.20	10.80	14.00
30	9.50	14.20	
20	13.90	20.80	27.00
10	25.90	33.20	

[a] This table was made by L. R. Henderson and E. C. Riley of Army Industrial Hygiene Laboratory in order to evaluate the results of patch tests with material to be used by the Army

If any cases of dermatitis are reported during the trial sale the manufacturer should engage the help of a competent dermatologist to investigate them and to determine the actual cause The continued sale of the cosmetic or its withdrawal from the market should depend on such an investigation.

Again it is emphasized that no tests so-far devised are an absolute guarantee of safety The final question is answered only after sufficient trial by many users over a long period

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CHAPTER XXII

ELECTROPLATING

ELECTROPLATING is the method of depositing a layer of one metal on the surface of another by means of an electric current. The essential apparatus consists of a tank holding a solution of the metal in the form of a salt and an immersed cathode and anode connected by wires to an electrical source. When the current is passed the metallic ion is deposited on the cathode and the acid radical at the anode. If the anode consists of a metal which can be attacked by the acid ion it is slowly dissolved. If the anode is made of the same metal as is being plated it replaces the loss of the metallic ions from the plating bath.

Before articles can be plated they must be thoroughly cleaned and polished. To remove grease and dirt the articles to be plated are washed in solvents such as gasoline and naphtha and then scrubbed with solutions of strong soaps and alkalis such as sodium hydroxide, potassium hydroxide sodium carbonate potassium carbonate and trisodium phosphate. Dermatitis may be caused by contact with these alkalis and fat solvents unless rubber gloves and aprons are worn.

The object to be plated is next "pickled" or dipped into a dilute acid solution to remove scale or oxide. Sulphuric, nitric, and hydrochloric acid or mixtures of them are used as a pickle. For the removal of fire scale sodium dichromate is added to the sulphuric acid pickling bath. Dermatitis and burns may result from splashes of the solution in the pickling tank and from drops of the solution which fall on the skin and clothing from the articles as they are taken out of the tank. After pickling the article is rinsed with water to remove the acid and then it may be necessary to polish and smooth its surface before it can be properly plated. Polishing is done with wheels of emery and rouge (soft iron oxide) and then lime paste or Tripoli powder (a form of soft spongy silica). The articles are then wired together and placed in a wire basket or container and lowered into the plating bath.

For chromium plating the plating bath contains chromic acid 25 to 40 per cent and sulphuric acid 0.2 to 0.4 per cent. Chromium sulphate or impure chromium carbonate may be used instead of chromic acid. The anode is usually lead or steel because metallic chromium is too expensive. The bath is replenished by adding more solution.

For copper plating the bath can be alkaline or acid. The alkaline copper plating bath contains about 3 per cent copper cyanide 3 per cent sodium cyanide and 1 per cent sodium carbonate. Or it may contain about 4 per cent basic copper carbonate and 5 per cent sodium cyanide or 2 per cent sodium sulphide. The acid copper

plating bath contains copper sulphate 25 per cent and sulphuric acid 5 per cent The anode is pure copper

The nickel plating bath contains nickel sulphate 10 to 25 per cent nickel chloride 3 per cent and boric acid 2 per cent The pH of the nickel plating bath is kept between 5 7 and 6 7 and the anode is pure nickel

The cadmium plating bath contains cadmium oxide sodium cyanide and sodium hydroxide The anode is pure cadmium.

The zinc plating bath contains zinc oxide sodium cyanide and sodium hydroxide

Silver plating is generally done on copper and the bath contains silver nitrate and potassium cyanide

Gold plating baths contain gold chloride and potassium cyanide

Platinum plating baths contain platinum chloride and potassium cyanide

All of the above plating baths except the one for nickel are primary skin irritants.

As the articles are taken from the plating baths and unwired the plating solutions drip on to the skin and clothes of the workers and may cause dermatitis and ulcers The article is rinsed with water and then is given a buffing and polishing The polishing and buffing of chrome plated articles is done by using a mixture of green or white chrome rouge (Cr_2O_3) and wax This is often deposited on the skin and in the nostrils

Fig. 38.—Occupational dermatitis (nickel plater) (Collection of Dr H ward Fox.)

Dermatitis and ulceration of the mucous membranes are common in small electroplating establishments where proper safety precautions are usually not as rigidly observed as in the large plants. (Fig 38)

In Ohio about 5 per cent of all occupational diseases are derma

toses or nasal ulcerations among electroplaters. Perforation of the nasal septum is far more common among chromium platers than among platers with other metals. The mist of chromic acid carried into the air of the room by the evolution of hydrogen at the cathode and especially concentrated over the plating tanks is highly corrosive and causes ulceration of the nasal and oral mucosa after two weeks exposure. Ulcers of the hands are also fairly common but dermatitis is not a common occurrence although cases of dermatitis and asthma due to hypersensitivity to chromium have been reported. In New York State out of 691 compensated cases of occupational dermatitis, only 8 have been among electroplaters.

Bloomfield and Blum (United States Public Health Reports September 7 1928) examined a number of small electroplating shops which employed a total of 19 men at chromium plating and found 7 cases of ulceration of the nasal septum and 6 cases of chrome ulcers of the hands. They made no mention of dermatitis. In Great Britain among 223 chrome platers, 95 were found who had dermatitis, ulcers, or scars of old ulcers and 116 had changes in the nasal mucosa, 37 of which were perforations and 79 ulcerations.

Dermatitis and ulcerations also result from the cyanide solutions in the alkaline copper plating baths and from the copper sulphate in the acid copper plating bath. These solutions may come in contact with the skin of the workers when they place articles in the baths and when they remove them from the baths. Cadmium zinc gold silver and platinum plating baths all contain cyanide and the spray of the plating solution causes dermatitis, mucous membrane irritation and ulceration. The acids and alkalis in the plating baths are also the cause of dermatitis and ulcers.

When dermatitis and ulcers occur among workers in an electroplating factory it is difficult to determine the exact chemical which causes them since most plating establishments do not confine themselves to plating with one metal. Indeed it is necessary in a great many instances to plate with two or even three metals in order to have a satisfactory result. For instance a good job of chromium plating may involve the following procedure

1. Wash article with soap and lye to remove dirt and grease
2. Pickle in acid.
3. Rinse in cold water
4. Polish (with emery rouge lime etc)
5. Clean with hot alkali solution
6. Rinse in water
7. Acid dip.
8. Rinse in water
9. Place in nickel plating solution
10. Rinse
11. Place in copper plating solution.
12. Rinse
13. Polish (rouge or soft buff)
14. Wash in hot alkali solution

15. Rinse.
16. Dip in solution of cyanide to remove copper oxide.
17. Dip in solution of hydrochloric acid.
18. Rinse.
19. Place in a nickel plating bath.
20. Rinse.
21. Polish (Vienna lime composition).
22. Wash in hot alkali solution.
23. Rinse.
24. Place in chromium plating solution.
25. Rinse.
26. Polish and buff using a mixture of green or chrome white and wax.

When a worker at all these processes has a dermatitis or ulcer it is sometimes impossible to state which of these irritants is the cause. It is likely that all of them contribute.

Sensitivity may also be present to any of the chemicals and may cause dermatitis. Nickel sensitivity frequently occurs not only among nickel platers but also among wearers of jewelry containing nickel. Dermatitis from the solution of nickel sulphate in the plating bath is more likely to be a sensitivity reaction than one due to the actual corrosive properties of the solution.

Goldman failed to obtain positive patch tests on workers with a 5 per cent solution of nickel sulphate. Jadassohn and Schaaf stated that the dermatitis among nickel platers was due more to dusting the articles with Vienna chalk than to the nickel sulphate. They performed patch tests with Vienna chalk and a 0.1 per cent solution of nickel sulphate and after twenty-four hours they found that the Vienna chalk caused redness and vesicles but that the nickel solution caused only a slight redness. Several patients were painted on the hands and thighs a number of times a day with a 20 per cent nickel sulphate solution for an average of forty-four days and in no case was any skin irritation noticed. Riehl however reported positive patch tests to 1 per cent and 10 per cent solutions of nickel sulphate in two electroplaters who suffered with eczema. Nekam reported a similar case and Burckhardt proved that the application of nickel sulphate to the skin can cause a sensitization which can be intensified and hastened when an alkali is added to the sensitizing solution.

PREVENTION OF DERMATITIS IN ELECTROPLATING

Workers engaged in washing and polishing should all wear rubber gloves reaching above the elbows and have the shirt sleeves buttoned at the wrist over the gloves. The hands and forearms should be covered with an animal fat such as lanolin before putting on the gloves and they should be thoroughly washed in soap and water after the gloves are removed at lunch time and before going home. Rubber aprons and boots should also be worn. The nasal orifices

of those who lean over the plating tanks should be loosely plugged with cotton smeared with vaseline and lanolin smeared over the face as protection against splashes.

Goggles should be worn by workers at plating and pickling tanks. The plating tanks should be constructed so that fumes spray and gases are removed from both anode and cathode ends by lateral suction located below the top edges of the tanks and about eight inches above the surface of the solution.

All polishing and buffing operations should be performed under exhaust ventilation and the polishers should wear rubber gloves. If they use lime and chromium oxide they should also place greased cotton plugs into the nostrils

Compulsory shower baths should be required of all workers before they go home from work

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CHAPTER XXIII

DERMATITIS FROM EXPLOSIVES

In times of peace explosives are not a large factor in the general causes of industrial dermatitis. In wartime, however, dermatitis from explosives is a serious problem to those concerned with the prevention of industrial diseases.

In the manufacture of explosives every possible precaution is taken against accidental explosions and fire. No one carrying matches is allowed to enter the inclosures where the buildings are located. The buildings themselves where the explosives are actually manufactured or mixed are isolated from each other and some of the most dangerous ones are surrounded by high explosion walls so that any explosion in the building is confined to that one area and will not spread to the other buildings. Each of these buildings has, leading from its windows and doors, explosion or fire chutes through which the workers can quickly dive out of the building to safety. In the buildings where explosive substances are handled only rubber and copper apparatus is used, no steel or iron being permitted because of the possibility of sparks. The workers are provided with shoes which have no nails in them and visitors are required to don rubbers over their shoes before entering the buildings. In some of the buildings where easily explodable substances such as nitroglycerine are manufactured, only two or three workers are allowed to work at one time so as to diminish the number of fatalities in case of explosion. In the large buildings where many workers are employed, those engaged in the handling of explosives usually work in little cubicles surrounded by metal walls so that any explosion in the cubicle will not spread to other parts of the building.

Explosives may be classified in the following manner: (1) propellants used to propel projectiles, and (2) military high explosives used for bursting charges and for setting off the more stable high explosives.

The propellants are smokeless powder and black powder.

The military high explosives are subdivided, the more stable explosives being used for bursting charges and the sensitive explosives for primers, fuses, boosters and detonators. Sensitive explosives are tetryl, mercury fulminate, lead azide, lead styphnate, tensyl and nitroglycerine. Stable explosives are trinitrotoluene (TNT), amatol, ammonium picrate (explosive D), lyddite (chiefly picric acid), pentaerythratoltetranitrate (PETN), hexite (hexanitrodiphenylamine) and dinitrotoluene (DNT).

Tetryl.—Tetryl, or trinitrophenylmethylnitramine, is a light yellow crystalline powder. It is made by sulfonating dimethylaniline and then adding this to nitric acid. The tetryl is separated from the

acid mixture and purified by recrystallizing from a solution of benzene or acetone. It is then taken to the drying chamber and dried

Dermatitis caused by tetryl is probably the most frequent cutaneous hazard accompanying the manufacture of munitions. It occurs in the making of tetryl, especially in the drying house where it develops in about 50 per cent of the workers it occurs also in the production of pellets and in the loading of fuses and boosters. One shell-loading plant for example, with a working population of 6,364 exposed to tetryl has reported 1904 (30 per cent) having tetryl dermatitis in the first six months of operation

Dermatitis generally occurs during the first three weeks of employment among those who have never before been exposed to the material cases reaching a maximum number about the third week. Most workers become "hardened" from one to four weeks after the development of dermatitis and are no longer irritated by tetryl. Especially is this true if they continue working while being treated It was noted at one shell-loading plant that about 85 per cent of the workers who had been affected became non-reactive while at another although exact figures are not available the incidence of dermatitis became lower the longer the workers were employed A small percentage of workers apparently never become completely insensitive and dermatitis develops whenever they are exposed even to minute quantities of tetryl. The amount remaining on a fellow worker's street clothes has in some instances been sufficient to light up dermatitis in a susceptible worker although the contact lasted only during the ride home Some workers become "hardened" more gradually or to a lesser degree and never quite to the point of complete immunity

The workers most frequently affected are those taking the tetryl into and out of the drying house, where they are exposed to large amounts of tetryl dust, those packing the tetryl for shipment those blending tetryl with graphite in the loading plants, those working at the pellet making machines, those inserting the pellets into boosters and those loading powdered tetryl into booster bags The blending of tetryl is done in explosion-proof compartments the operator being outside at a considerable distance (remote control) The pelleting is done in a similar manner except that the operator watches through a slit in the walls or sees the operation from a distance by means of mirrors

The most frequent sites of tetryl dermatitis are about the mouth on the cheeks, around the eyes and on the neck. (Figs. 39 and 40) In some cases there is considerable edema of the face the eyes being swollen shut. Dermatitis of the hands, the arms, the genitals and other parts of the body touched with soiled hands may also occur but is infrequent Nosebleed without ulceration of the nasal mucosa often occurs. The skin itches, then becomes erythematous and papules and vesicles may develop The palms and fingers are usually stained dark yellow and the hair of blonds becomes a typical

"tetryl red" Most workers show staining of the hands, and a few coloration of the hair without any evidence of cutaneous irritation. Workers thus affected are sometimes called "canaries" The epithelium of the palms is indelibly stained and it takes two or three weeks after exposure ceases for the stain to fade out

The treatment of tetryl dermatitis consists in the application of cold boric acid dressings to the swollen face followed by mild ointments as the swelling disappears and desquamation occurs.

The stain on the hands is difficult to remove The use of a 10 per cent aqueous solution of sodium sulphite followed by washing with

FIG 30 — Dermatitis in a worker exposed to tetryl

soap and water is thought to be the best way to remove it The sodium sulphite may be incorporated into the soap or potassium sulphite may be put into liquid soap which reduces the time required for removal of the stain This method of washing the hand also serves as an indication of the removal of the free tetryl for as long as there is free tetryl on the skin a purple color will show in the sodium sulphite solution

The following preventive measures are recommended (1) Freshly laundered coveralls should be provided daily for every worker exposed to tetryl (2) Workers handling tetryl should wear (*a*) soft washable leather gloves fastened at the wrists so that the dust

cannot fall into the gloves, (*b*) impervious sleeves fastened around the glove at the wrist and extending up to the axilla to protect the arms and (*c*) impervious aprons for the protection of the anterior surfaces of the body (3) As compulsory shower baths after work are an important factor in the prevention of tetryl dermatitis, time at the company's expense should be allowed the workers for taking the baths. (4) Since the skin of the face is affected from touching it with soiled fingers and from irritation caused by the respirator touching the face a protective preparation should be applied to it Such an application should be of the invisible glove type reinforced

FIG. 40 —Dermatitis from tetryl.

by a powder to prevent it from being easily penetrated by sharp particles. The formula given in Table 11 was found to give better protection than any other available The shellac forms the film on the skin when the alcohol evaporates. In the film are embedded the solid ingredients for reinforcement. The perborate liberates oxygen when it is wetted. The oxygen tends to detoxify tetryl. The linseed oil plasticizes the shellac and the carbitol permits the film to be removed after work by washing with water

The water soluble type of invisible glove application also gives considerable protection. The formula given in Table 12 incorporates it with a reinforcing powder

Reliance for the prevention of tetryl dermatitis should not be placed on protective ointments alone. These should be used in conjunction with all the other preventive methods mentioned. All workers need not use all these protective measures. Those who have worked for a long time without getting dermatitis or those who have become non-reactive need not do any more than wear clean protective clothing and take shower baths after work. Only new workers and those who are sensitive to tetryl must observe all these preventive measures.

Systemic poisoning from tetryl is a disputed subject. While some cases have been reported, most authorities deny its occurrence.

Petrolatum inserted into the nostrils several times a day may prevent congestion of the nasal mucosa and nosebleed. The hair can be protected from the dyeing action of tetryl by wearing a close-fitting cap or hood.

To perform patch tests with tetryl, place a small amount of the powder on a piece of gauze about ½ inch square and 4 plies thick, slightly moistened with acetone. Apply to the normal skin, cover with a piece of cellophane 1 inch square, and this with a 2 inch square piece of adhesive plaster. Allow to remain on for twenty-four hours and then read the reaction. Read again three days later for delayed reactions. The gauze may also be moistened with a saturated solution of tetryl in acetone, allowed to dry, and applied as a patch test.

Trinitrotoluene (TNT).—Trinitrotoluene or TNT is the most commonly used bursting charge. It is made by nitrating toluene to mononitrotoluene, nitrating this to dinitrotoluene and then nitrating this to trinitrotoluene. This is washed with hot water until there is no more acidity. Then the neutral trinitrotoluene, now in the form of an oily liquid, is run into crystallizing kettles and from there into graining kettles. It is then transported to where it is boxed with non-sparking tools. Workers with this explosive should wear shoes containing no nails.

Trinitrotoluene resembles light brown sugar. It is soluble in ether, acetone and alcohol but is insoluble in water. On entering a room in which the dust of this explosive is present one experiences a bitter taste.

Dermatitis from trinitrotoluene begins to occur at the operation in which the product is washed with hot water to neutralize the acid and occurs from there on at every stage of the manufacturing, packing and bomb and shell loading processes. Workers engaged in unloading the boxes at the plants where shells are loaded, those pouring the trinitrotoluene into the melting boxes, those pouring it into shells and bombs, those drilling holes in it in the shells to make room for the booster and those inserting it into primers are especially likely to become sensitized and show dermatitis after five or more days of exposure. The hands, wrists and forearms are most commonly affected, but the dermatitis is often found at points of friction, such as the collar line, the belt line and the ankles.

A more or less generalized dermatitis may occur but is rare. The lesions on the palms are characteristic, resembling somewhat the deep-seated vesicles of a phytid. They are deeper seated and larger (pea sized) and are accompanied by considerable edema. The dorsa of the hands are also usually edematous, and even the forearms up to the elbows may be affected (Fig. 41.) In seven to fourteen days the inflammation usually subsides and the skin peels in large thick pieces from the palms, in smaller pieces from other parts, leaving new skin beneath. The lesions on other parts are not characteristic consisting of papules and vesicles followed by flaky desquamation.

TABLE 11.—PROTECTIVE PREPARATION AGAINST TETRYL DERMATITIS

	Parts
Shellac	13
Isopropyl alcohol	31
Linseed oil	4
Titanium oxide	13
Sodium perborate	15
Talcum	20
Carbitol (mono-ethyl ether or diethylene glycol)	3

TABLE 12.—WATER SOLUBLE APPLICATION

Casein	20
Zinc oxide	20
Iron oxide	2
Water	58

Trinitrotoluene stains the skin of the hands a light yellow and discolors the hair to a reddish blond.

It may be taken into the system through the respiratory and gastro-intestinal tracts and may be absorbed through the skin to cause anemia, leukopenia and yellow atrophy of the liver. Workers exposed to it often show cyanosis, or "blue lip," a livid purple of the lips and blueness of the face. They should be examined periodically for changes in the blood and hepatic damage.

The treatment of dermatitis caused by trinitrotoluene consists in the application of mild wet dressings such as boric acid solution and solution of aluminum acetate in the acute stages and the use of mild ointment such as boric acid ointment or zinc oxide ointment when the acute symptoms subside.

Workers with mild dermatitis should be treated while working in order to give them an opportunity to get well on the job and become "hardened" as the majority do. While working they should be given protective clothing in the form of dustproof sleeves and aprons, in addition to a daily change of clean coveralls, stockings and underclothes. Washable soft leather gloves with smooth seams should also be provided and cleaned daily. They should fit snugly at the wrists to prevent the entrance of the dust of trinitrotoluene and the sleeves should be fastened over them at the wrists. All workers with this explosive should take cleansing showers after work, before leaving the factory, and they should wash their hands before their meals. A liquid soap containing 10 per cent potassium sulfite may be used. This will give a purple color as long as free trinitrotoluene is on the skin. The Webster test will also show the

presence of this substance on the clothes or the skin It consists in dissolving 10 per cent sodium hydroxide in alcohol and applying a drop to the clothing A purple color develops if trinitrotoluene is present

All workers should be given the protective clothing advised in the foregoing paragraph While ointments are not to be relied on to give as much protection as the measures recommended if for some reason or other they must be used the type described for protection against tetryl is also the best for protection against trinitrotoluene

Fig. 41 — Dermatitis from TNT

Amatol and Ammonal.—Amatol is a mixture of ammonium nitrate and trinitrotoluene It is made by preheating ammonium nitrate and letting it mix with molten trinitrotoluene usually in the proportion of 50 parts each or that of 80 parts ammonium nitrate to 20 parts of trinitrotoluene The hazard treatment and prevention of dermatitis are the same as for trinitrotoluene. Ammonal is a mixture of ammonium nitrate and powdered aluminum Dermatitis from it is not as frequent as that from amatol.

Ammonium Picrate (Explosive D)—Ammonium picrate or explosive D is made by reacting a hot aqueous solution of picric acid with ammonia and crystallizing the ammonium picrate by cooling In the form of the wet crystals it is taken to the dry house

and dried by circulating warm air. It is then packed in waterproof boxes.

Ammonium picrate consists of orange colored needle shaped crystals. It is soluble in water, has a bitter taste and dyes the skin, hair and clothes of workers exposed to it. It is used as a bursting charge in armor piercing shells, into which it is loaded by pressing. Because it attacks metals, the inside of the shell is coated with a non-metallic paint or varnish.

From the time it is in the wet crystal stage up to the time of loading the shells ammonium picrate causes sensitization dermatitis among workers exposed to it. Those handling the dry product are the ones most affected. The face is usually involved, especially around the mouth and the sides of the nose. There are edema, papules, vesicles and finally desquamation. "Hardening" occurs as described for tetryl and trinitrotoluene. The treatment and the preventive measures are the same as for tetryl and trinitrotoluene.

Picric Acid.—Picric acid, or trinitrophenol, can be made from benzene or from dinitrophenol. It is a lemon yellow crystalline solid only slightly soluble in water but soluble in alcohol, benzene and other organic solvents. It stains the skin, the hair and the clothing of workers yellow. It has a bitter taste.

Picric acid causes dermatitis similar to that described under ammonium picrate.

Mercury Fulminate.—Mercury fulminate is a brownish yellow heavy crystalline solid made by the action of alcohol on mercuric nitrate. There is but little dermatitis among workers engaged in its manufacture. It is used in detonators and primers and is one of the most frequent causes of dermatitis in shell loading plants. It causes sensitization dermatitis, and it can also cause ulcers if it enters abrasions. Because of its sensitivity, mercury fulminate is stored wet. Before use it is dried and delivered in small amounts to the detonator lines. It may be used to fill the detonators while it is still wet, and in this case the detonators are placed in drying rooms to dry.

When used for primers, mercury fulminate is mixed with other ingredients, such as antimony sulfide or potassium chlorate. In the making of detonators there is a certain amount of exposure to the dust in practically all of the operations, and most of the dermatitis from mercury fulminate occurs in a manufacture of detonators. In the making of primers the mercury fulminate is usually handled wet and the workers wear rubber gloves or finger cots.

Dermatitis from mercury fulminate occurs mostly on the face and anterior surfaces of the arms, but other parts of the body may also be affected (Fig. 42). If the wet primer mixture is dropped on the clothing, the powder when it dries will sift through the clothing to the skin and cause dermatitis on the covered parts of the body. The inhalation of the dust of mercury fulminate causes nasal irritation. Rubbing the nose with soiled hands or gloves is often the

presence of this substance on the clothes or the skin It consists in dissolving 10 per cent sodium hydroxide in alcohol and applying a drop to the clothing A purple color develops if trinitrotoluene is present

All workers should be given the protective clothing advised in the foregoing paragraph While ointments are not to be relied on to give as much protection as the measures recommended If for some reason or other they must be used the type described for protection against tetryl is also the best for protection against trinitrotoluene.

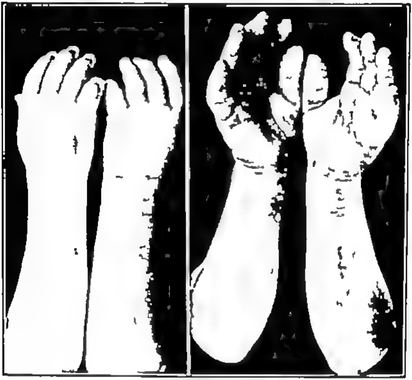

Fig 41 —Dermatitis from TNT

Amatol and Ammonal.—Amatol is a mixture of ammonium nitrate and trinitrotoluene It is made by preheating ammonium nitrate and letting it mix with molten trinitrotoluene usually in the proportion of 50 parts each or that of 80 parts ammonium nitrate to 20 parts of trinitrotoluene The hazard treatment and prevention of dermatitis are the same as for trinitrotoluene Ammonal is a mixture of ammonium nitrate and powdered aluminum Dermatitis from it is not as frequent as that from amatol

Ammonium Picrate (Explosive D)—Ammonium picrate or explosive D is made by reacting a hot aqueous solution of picric acid with ammonia and crystallizing the ammonium picrate by cooling In the form of the wet crystals it is taken to the dry house

and dried by circulating warm air It is then packed in waterproof boxes

Ammonium picrate consists of orange colored needle shaped crystals. It is soluble in water has a bitter taste and dyes the skin, hair and clothes of workers exposed to it. It is used as a bursting charge in armor piercing shells, into which it is loaded by pressing Because it attacks metals, the inside of the shell is coated with a non-metallic paint or varnish.

From the time it is in the wet crystal stage up to the time of loading the shells ammonium picrate causes sensitization dermatitis among workers exposed to it. Those handling the dry product are the ones most affected The face is usually involved especially around the mouth and the sides of the nose There are edema papules, vesicles and finally desquamation 'Hardening' occurs as described for tetryl and trinitrotoluene The treatment and the preventive measures are the same as for tetryl and trinitrotoluene.

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When used for primers mercury fulminate is mixed with other ingredients such as antimony sulfide or potassium chlorate. In the making of detonators there is a certain amount of exposure to the dust in practically all of the operations and most of the dermatitis from mercury fulminate occurs in a manufacture of detonators. In the making of primers the mercury fulminate is usually handled wet and the workers wear rubber gloves or finger cots.

Dermatitis from mercury fulminate occurs mostly on the face and anterior surfaces of the arms but other parts of the body may also be affected (Fig 42.) If the wet primer mixture is dropped on the clothing the powder when it dries will sift through the clothing to the skin and cause dermatitis on the covered parts of the body The inhalation of the dust of mercury fulminate causes nasal irritation. Rubbing the nose with soiled hands or gloves is often the

means of carrying the chemical to the face Conjunctivitis also occurs in a considerable number of these workers

In occupational dermatitis the etiologic rôle of the other ingredients in primers and detonators must not be overlooked and if it is desired to find the actual cause of dermatitis among workers patch tests should be performed with the various ingredients in the explosive mixtures Petrolatum inserted into the nostrils will afford protection from nasal irritation as described under tetryl

Fig. 42. Dermatitis in ammunition worker from fulminate of mercury

Hexite —Hexite or hexanitrodiphenylamine is a yellow crystalline solid soluble in alcohol and in acetone It is manufactured from dinitrochlorobenzene and it causes vesicular dermatitis of the hands followed by desquamation similar to that described under trinitrotoluene among workers engaged in its manufacture and among those engaged in loading it into shells and bombs.

Hexite is now being made and used but not in as large quantities as trinitrotoluene The incidence of dermatitis from it is higher than that from trinitrotoluene It causes irritation of the mucous membranes of the nose and the mouth and it stains the skin and the hair yellow It also causes systemic poisoning similar to that caused by nitroglycerine

Pentaerythritoltetranitrate (Petn) —Pentaerythritoltetranitrate (PETN) a new explosive is used as a bursting charge Dermatitis or systemic poisoning has not yet been reported as being caused by it

Black Powder and Smokeless Powder —Black powder was the first propellant and until 1870 it was practically the only propellant used Today however it is used only for igniter charges for expelling charges from shrapnel for primers and in the manufacture of fuses. Black powder is a mixture of potassium or sodium nitrate charcoal and sulphur It is only a rare cause of dermatitis

Smokeless powder has entirely displaced black powder as a military propellant. The principal raw products used in the manufacture of smokeless powders are cotton and wood cellulose, sulphuric acid, nitric acid, dinitrotoluene, dibutyl phthalate, diphenylamine, potassium nitrate, barium nitrate, ammonium nitrate, sodium nitrate, ethyl alcohol, toluene, benzol, ether and nitroglycerine is also used in some smokeless powders.

Nitro cotton is manufactured from second cut cotton linters or from cellulose. These are cleaned, dried and then mixed in large vats with a mixture of sulphuric and nitric acids. The vats are situated in a room with a door so arranged as to permit the men to easily escape in case of fire or explosions. When not actually engaged in watching the mixture or testing it the men stand behind a metal fire screen and while watching the mixing process they wear metal fire helmets fitted with mica eye shields. They are also required to wear rubber gloves and woolen clothes to resist the action of acids and their shoes must have rubber soles and no nails in them whatever. Aluminum scuppers are used to stir the mixture and the tanks are made of material which will not spark. Fumes of the higher oxides of nitrogen are formed in the nitrating process and are carried out of the building by forced draft and discharged long distances from the plant because the fumes are exceedingly poisonous and if inhaled may cause severe congestive pneumonia and death. When a worker does inhale these fumes he usually does not feel any effect from them until a number of hours later, perhaps when he has gone home from work, and then he is taken with difficulty in breathing and the congestive pneumonia results. Old workers are familiar with this hazard but new workers should be instructed not to go near the places where these fumes are discharged.

After the nitration of the cotton is completed, the acid is drained out of the tank and water is introduced to drown the cellulose nitrate mixture. The wet nitro cotton is then mixed with fresh water and the mixture is boiled a number of times in order to remove all traces of acids and impurities. It is further purified by passing through pulping and poaching machines and a solution of soda ash is added to neutralize completely any remaining acid. It is then run through a screen and dried to a 30 per cent moisture content in centrifugal driers.

Most of these operations are totally enclosed and entail no skin hazards.

The moist nitro cotton is then carried to another building where it is put into a press and alcohol is allowed to run through the press to displace the water. When it comes out of this press it contains 30 per cent alcohol instead of 30 per cent water which it contained before it entered the press. The mold is now broken up into small pieces of powder-like consistency and mixed with dinitrotoluol, dibutyl phthalate and diphenylamine and other compounds such as the nitrates, and made into a doughy cheese-like mass and pressed

into a solid piece called a "cheese." When nitroglycerine is used in smokeless powder it is first mixed with acetone before it is added to the nitro cotton diphenylamine and dinitrotoluol. Dinitrotoluol and the nitrates are skin irritants and the workers who handle them in mixing with the other ingredients may if sensitive develop a dermatitis, although no such cases at this operation were seen by the authors. The "cheese" is now placed in a can and transported to a machine called a "macaroni machine" which forces it out in macaroni-like shapes. The macaroni threads are then sliced into small pieces and again passed through a screen to remove impurities and foreign matter and then it is passed through another mold press from which it emerges in an endless string of the desired diameter with perforations. These strings are then cut into suitable lengths. The powder at this stage is soft and contains a considerable amount of ether and alcohol and it is taken to a building where it is heated by circulating hot air to remove and recover the solvent. After the ether and alcohol have been removed the product is wetted with water to prevent explosion and is loaded into bags and removed to a building where it is again dried spread out and sorted to remove imperfect pieces. The large grain powder is called cannon powder and the smaller grain is used for shot guns and rifles. The smaller grain powder is polished with a glaze of graphite by revolving in a barrel containing graphite

Only 2 cases of dermatitis were seen in the factories manufacturing smokeless powder Both of these cases were attributed to dinitrotoluol However a large percentage of the workers engaged on the presses in replacing the water of the nitro cotton with alcohol who were exposed to the fumes of alcohol were observed to have dilated arterioles on the face resembling that seen on the faces of chronic alcoholics It is believed that the inhalation of the fumes of alcohol produces this effect. A few of these workers suffered from chapped hands probably the result of the alcohol extracting the fat from the skin. It would be advisable to provide exhaust hoods over the processes to remove the fumes of alcohol and ether from the air and to provide those handling the alcohol-wet cotton with rubber gloves to prevent the action of the alcohol on the skin Also it would be well to provide lard or lanolin for the workers to rub into the skin after work to replace the fat removed by the alcohol The wearing of rubber or washable leather gloves will reduce the cutaneous absorption of nitroglycerine and help to prevent systemic effects.

Dynamite Manufacture —On account of the great sensitivity of this explosive the most stringent precautions are carried out in its manufacture A cast iron tank fitted with refrigerating coils is filled with a mixture of sulphuric and nitric acids glycerine is slowly added and the mixture is agitated to form trinitroglycerine The mixture is run into lead lined vats and allowed to settle the trinitroglycerine separating from the waste acid and rising to the top. The trinitroglycerine is then run off in a rubber lined trough

to the trinitroglycerine storage tanks where sodium carbonate is added in order to neutralize whatever acid may be left. Materials added to trinitroglycerine in order to make dynamite are called "dope" and the mixing of these materials with the nitroglycerine is done in the "dope house." The "dope" usually consists of wood cellulose, various nitrates and some inert powders such as Kieselguhr, a porous earth capable of absorbing nitroglycerine. There is considerable dust raised in these operations and the men are usually covered with the ingredients unless proper exhaust vents and totally enclosed processes are used and dermatitis from the irritant chemicals such as the nitrates occurs at times amongst them.

Gelatine dynamite is made by mixing nitro cotton with the liquid trinitroglycerine forming a soft solid mass. Loose powder dynamite is pressed into paper capsules to form cartridges. These cartridges are then lowered into molten paraffine in order to seal them and make them waterproof.

New workers with nitroglycerine often develop a nitroglycerine headache. Most all of the older workers have become immune but there are still some who will develop a headache when coming to work on a Monday after the week-end rest. This headache usually disappears by Tuesday or Wednesday.

Workers handling nitroglycerine should wear rubber gloves and clean work clothes furnished fresh each day to protect them, not only from skin irritation but against the skin absorption of nitroglycerine. In addition to this they should be required to take cleansing shower baths after work and to have a double system of locker rooms, that is one for street clothes and another in which they can deposit their soiled work clothes.

Chlorates and Nitrates.—Potassium chlorate and potassium and ammonium perchlorate are also used as oxygen suppliers in explosive mixtures. They are also used in signal and pyrotechnic compositions. R. Prosser White quotes Montesano as reporting dermatitis from potassium chlorate among ammunition workers and ulceration of the nasal septum among workers making sodium chlorate by electrolysis. No such cases were seen in the factories examined.

Potassium nitrate, sodium nitrate, ammonium nitrate and barium nitrate are also used in explosives as oxygen carriers. Ammonium nitrate is also mixed with dinitronaphthalene to form the explosive known as "Schneiderite." Ammonium nitrate is also the chief ingredient in "Ammonal" in which it is mixed with powdered metallic aluminum, potassium nitrate and charcoal.

The dust of the nitrates is said by R. Prosser White to cause a dermatitis under certain conditions in hypersensitive workers, especially the ammonium nitrate. This same compound is said to cause smarting in any sores or cracks.

In a factory where large quantities of powdered and granular ammonium nitrate were prepared from concentrated aqueous solutions no cases of dermatitis were found from this product, perhaps

because the workers were properly protected by rubber gloves and daily change of work clothes

In the pyrotechnic department of a large arsenal sulphur nitrates and powdered aluminum were weighed out in a room and mixed for the manufacture of pyrotechnics. Although this operation entailed the generation of considerable dust which permeated the air no cases of dermatitis occurred in that area for a number of years. This might also have been due to the fact that the workers in this arsenal were required to take shower baths after work and were furnished with clean work clothes daily

Manufacture of Blasting Caps —Copper or aluminum sheets are placed in machines and stamped and drawn out into proper cup shapes. During this operation the machines are constantly doused with a drawing compound of a sulphonated oil in order to make the stamping easier and to cool the machines. The connections for the electric blasting caps are made by winding cotton around copper and iron wire The cotton-surrounded wire is then passed through paraffine if made of iron and through asphalt if made of copper The ends of paraffine wires are passed through a flame to burn off the paraffine for a distance of about 3 inches. The ends of asphalt wires are dipped in hot lead for the same purpose The workers employed in this operation wear rubber gloves to protect their hands from dermatitis and new growths which may occur from exposure to paraffine and tar No cases of dermatitis or warts were seen among these workers.

The end of the copper wire is dipped in hydrochloric acid and then into molten tin to put a coating of tin over the copper The two wire ends are then fused into a small plug consisting of a mixture of sulphur mica and asphalt The workers employed in this operation all wear rubber gloves. The ends of the wire which project from the small plug are then bridged by a fine wire soldered to them In this operation dermatitis sometimes develops from the compound used in soldering The projecting ends of the wires are then stuck into loaded blasting caps This operation is performed by workers in separate metal walled cells in order to minimize explosion hazards. After sticking the ends into the blasting caps hot asphalt is poured in and over this a mixture of molten sulphur which solidifies and embeds the wire into the blasting cap There are plugs on the ends of the wire which is put into the blasting cap and these plugs prevent the hot sulphur and asphalt from coming in contact with the explosive in the blasting cap.

No cases of dermatitis were seen among the workers engaged in this operation and this may be due to the fact that there is a suction exhaust hood over the molten sulphur and asphalt mixture which draws off fumes and dust Before this suction ventilating apparatus was installed dermatitis among these operators was quite frequent

The finished blasting caps containing the wire are then electrically tested with a battery having a capacity no greater than 0.22 amperes.

This can safely be done because it requires at least 0.30 amperes to detonate the blasting cap.

Those who work at testing the electric blasting caps must press the wires against the contact points and in doing this are apt to traumatize the finger tips. In order to protect the finger tips they wrap friction tape around their fingers. In a factory manufacturing blasting caps many cases of dermatitis have occurred from the friction tape. (Fig. 43.) Friction tape contains a number of skin irritants, such as reclaimed rubber, resin, etc. In order to prevent this, the girls should be instructed to wrap a layer or two of gauze or cellophane around their fingers and to apply the friction tape over this.

FIG. 43.—Dermatitis, thumb and forefinger of munitions worker engaged in testing blasting caps; due to friction tape which is wrapped around fingers for protection against wire cuts.

The blasting caps are usually filled with combinations of tetryl, mercury fulminate, lead azide, and potassium chlorate. These operations take place behind steel shields. The first load usually consists of tetryl which is shaken down to the bottom of the cap. This is then placed in a rubber block and passed into another steel shielded compartment where the tetryl is tightly pressed to the bottom of the cylinder. The cap is then passed into still another steel shielded compartment where lead azide is loaded into it in a similar manner and in still other compartments are added such compounds as mercury fulminate, lead sulphocyanate, potassium chlorate, ground glass, and smokeless powder.

In the operation of filling blasting caps the powdered tetryl and the mercury fulminate are the chief skin hazards, although workers may become sensitive to any of the other ingredients.

Ordinary blasting caps are exploded by fuses or ignition leads.

The ignition leads usually consist of mixtures of lead sulphocyanate potassium chlorate and sulphur

All the operations above described in making blasting caps are done behind steel shields and in most operations the worker stands behind the shield and operates levers which accomplish the mixing by remote control Men employed on these operations are usually men who have been working in the plant for a number of years and are selected especially because of their carefulness and apparent immunity to dermatitis from these explosives. Despite this care mercury fulminate and tetryl in dry powdered form sometimes cause a dermatitis.

Lead Azide.—Lead azide is manufactured by the action of lead nitrate on sodium azide. The solution of lead nitrate containing a small amount of sodium hydroxide and dextrin is stored in a separate building from the solution of sodium azide so that there is no danger of the two solutions ever coming together on the floors of the room and forming a possible explosive. The solution of sodium azide is slowly run into the solution of lead nitrate and churned in a precipitator The precipitator is located in a room which has very thick explosive-proof walls and is equipped with a powerful exhaust fan to remove the fumes of hydrozoic acid which are generated during the reaction and are very poisonous, only a few whiffs being needed to cause a severe headache The operator stands outside the room watching the reaction through a peephole and enters the room only after the exhaust fan has been running some time following the completion of the reaction In spite of this precaution, the operator sometimes develops a headache similar to that occurring in the manufacture of nitroglycerine.

The liquor remaining in the precipitator a solution of lead nitrate and sodium and lead azide is dropped into receiving tanks where it is mixed with sodium nitrite and weak nitric acid and then soda ash is added. This makes the mixture safe so far as explosions are concerned It is now dumped The precipitated lead azide remaining in the precipitator is now dumped on a filter cloth and then brought into another room where it is washed with water dried and then sieved Dermatitis from lead azide is rare

Lead Styphnate —Lead styphnate is a reddish-brown powder which is used in priming mixtures. It is manufactured by adding sulphuric acid to resorcin and then nitrating resulting in the formation of trinitro resorcin. This is then mixed with magnesium oxide and the resulting magnesium styphnate is added to a solution of lead nitrate The two solutions are kept in separate rooms and are allowed to react with each other in a third room in a similar manner to that described under lead azide manufacture Both the trinitro resorcin and the lead styphnate turn the hair and skin yellow and cause dermatitis in sensitive workers.

Sensol a canary yellow colored powder manufactured by the action of sodium nitrate on amino guanidine sulphate is also used

in priming mixtures and causes dermatitis in hypersensitive individuals

Cartridge Manufacture.—Dermatitis chiefly in the finger webs occurs among workers on drawing operations caused by the alkaline coolant which flows in a continuous stream over some of the process. Workers so affected should be given rubber gloves, or an ointment consisting essentially of lanolin 70, castor oil 30, to apply to the hands before and after work.

Workers dipping cartridge cases in mercurous nitrate solution to detect cracks should wear rubber gloves.

Girls gauging, weighing, inspecting or otherwise handling cartridges should be provided with canvas or washable chamois gloves to prevent traumatic dermatitis of the fingers and paronychia caused by the metal.

Workers loading tracer bullets are exposed to the irritant dust of the tracer mixture. Nose and throat irritation can be prevented by the use of respirators and dermatitis by using the protective ointment recommended against tetryl.

Traumatic dermatitis of the thighs caused by bumping or leaning against the sharp metal edges of ammunition trucks can be prevented by padding the edges of the trucks or by having the girls wear pads under their dresses.

Girls coating shellac on paper covers for primer sealing, "foiling" should wear rubber gloves and impervious sleeves and aprons, to prevent dermatitis from the shellac solvent and the primer charge.

Girls loading primers pass the palms over the loading plates and some develop a deep-seated vesicular eruption on the palms resembling that caused by TNT although antimony sulphide may be a contributing factor. These girls should also wear rubber gloves and impervious sleeves and aprons.

Workers in the pre-mix and the primer-mix departments are exposed to the dust of the explosives and should wear rubber gloves, impervious sleeves, aprons and respirators. Cutting oil dermatitis may occur in the tool and die shop. (See section on Cutting Oils.)

Workers with brass will complain of what they call "brass poisoning." Every cut and every case of dermatitis will be called "brass poisoning" by some of the workers. Slivers of brass cause dermatitis just as slivers of any other metal by wounding the skin. Secondary infection of these wounds may occur as in wounds from any other metals. Actual sensitivity to brass has not been demonstrated.

Shell and Bomb Loading.—Workers in plants where shell loading, bomb loading, trench mortar shell loading, and renovating of projectiles are performed, are exposed to skin hazards not only from all the explosives used but also from the solvents used for degreasing and for paint thinners.

Tetryl.—Tetryl may cause sensitization dermatitis usually on the face five days to several months after work is begun. It will stain the skin and hair a yellow color and will cause nose bleed. Workers engaged at weighing, screening and blending tetryl are

exposed to large quantities of tetryl dust and should be provided with clean work clothes daily. They should insert lanolin or vaseline into the nostrils several times a day to protect the mucous membranes. They should be provided with a protective ointment to use on the face, arms and hands. If rubber gloves or soft washable leather gloves, impervious sleeves and aprons are worn, the protective ointment need not be applied to the hands and arms. Showers after work should be compulsory.

Workers engaged in making tetryl pellets are exposed to tetryl dust when filling and cleaning the hoppers and when handling the finished pellets. They should be protected with protective clothing, ointments, and compulsory showers as described in section under Tetryl. Workers loading boosters with tetryl pellets or filling small bags with tetryl, and those placing the boosters into shells, as well as those placing tetryl into hand grenades and into fuses are all exposed to tetryl dust and should be protected as described above.

TNT.—TNT may cause sensitization dermatitis after five days to several months of exposure. It stains the skin and hair a yellow color, but not so pronounced as does tetryl. While TNT does not cause nosebleed, it often causes cyanosis or "blue lip." TNT usually attacks the hands, but cases of generalized dermatitis may also occur. Workers engaged in weighing, screening and sifting TNT are exposed to considerable TNT dust. They should be furnished clean work clothes daily, and showers should be compulsory and supervised after work. Impervious sleeves and aprons and soft washable chamois or leather gloves should be provided and washed daily. (Steeping the gloves in a 10 per cent solution of sodium bisulphite followed by several rinsings in water decontaminates them.) A protective ointment as described under Tetryl may be applied to the face and other exposed parts. Workers melting TNT and those pouring it into shells and bombs, as well as the tappers and drillers, should be given the same protection as described above.

Folliculitis and boils sometimes occur on the hands and arms of workers with molten TNT and are caused by the crystallization of the TNT as it cools, and the enmeshing of the hairs. When the crystals are pulled off the skin the hairs are pulled out and infection may result. Protective clothing will prevent this.

Dinitrotoluene.—Dinitrotoluene (DNT) is used in smokeless powder. While it causes sensitization dermatitis it does not affect as many workers as does TNT, nor are the cases as severe. The preventive measures are the same as for TNT.

Fulminate of Mercury.—Fulminate of mercury is used in detonators and primers, and affects a considerable percentage of the workers. Even when handled wet, as it is in detonators, it will dry on the clothes, sift through, and cause dermatitis on the covered parts, such as the abdomen and the chest. Soiled fingers may carry it to the genitals and cause dermatitis on those parts.

Fulminate of mercury is also used in primers when it is mixed with antimony sulphide, potassium chlorate and ground glass. The

dermatitis among workers filling primers may be caused by the fulminate of mercury or the antimony sulphide or both. Patch tests with the primer ingredients will determine the actual irritant. The protective measures recommended are those given for Tetryl or TNT

Ammonium Nitrate.—Ammonium nitrate used with TNT to make amatol is a relatively mild skin irritant and workers protected against TNT are protected against ammonium nitrate

Lead Azide.—Lead azide is used only in small quantities. Dermatitis from it may occur but is rare

Patch Tests.—In the performance of patch tests the explosives can be applied to the skin in powdered form on a piece of gauze and allowed to remain for forty-eight hours. Late reactions should be looked for up to three days after removing the patches.

Solvents.—Solvents are used to a large extent in cleaning and degreasing shells, in spray gun stenciling and in renovating old projectiles. Kerosene petroleum spirits, Stoddard solvent and oakite are some of the solvents used and all can cause dermatitis by their defatting and keratogenous action on the skin. Workers in contact with such solvents should wear solvent-proof gloves, sleeves, and aprons. If for any reason these cannot be used, protective ointments special cleansers and emollient creams should be supplied to the workers. Workers should not be permitted to dip the unprotected hands in these solvents. See section on Prevention Protective Ointments, and Cleansers.

Asphalt Paint.—Girls using asphalt paint on primers should be provided with synthetic rubber gloves, or if this is not feasible a protective ointment and a special skin cleanser to remove the paint from the hands.

Finger cots should be provided for workers loading cartridges with smokeless powder and for those spring-arming fuses, to protect them from cuts from the silk cords and scratches from the spring

Manufacture of Shot Gun Shells.—Shells for shot gun ammunition are made by rolling paper into cylindrical shapes and pasting them into tubes and then drying The tubes are waterproofed by spraying with China wood oil and again allowed to dry Dermatitis occasionally occurs during the waterproofing operation due to hypersensitivity to the China wood oil. After waterproofing the tubes are sized and corrugated and then immersed in wax to make them fireproof They are then cut into proper lengths.

The brass heads are manufactured by a series of drawing and stamping machines. During this process, the brass parts are pickled in sulphuric acid and then are dipped in a solution of sodium bichromate in order to brighten them

Chrome ulcers were seen in a number of workers at this operation.

Lead shot for shot guns is manufactured by melting lead mixing it with antimony and arsenic and pouring the molten mixture through a sieve at the top of a high tower and allowing the drops to fall into a tank of water at the bottom Cases of dermatitis occur at times among the men mixing the arsenic and antimony with the

lead Workers at this operation should be protected against these three poisons by clean protective clothing respirators proper ventilation and by periodic medical examinations

Shells for small caliber rifles are manufactured by a series of drawing and stamping machines The operations are continually flushed with a cutting compound and dermatitis of the hands and forearms occurs among workers sensitive to the oily contents of this compound Folliculitis may also occur if the sleeves and the trouser legs are allowed to become saturated with the oil and are worn for a number of days without washing

In some factories it was thought that the dermatitis and folliculitis were due to bacteria in the cutting compound and a diminished number of cases of dermatitis and folliculitis was observed when an antiseptic was added to the compound The cutting compound was used over and over again and contained fine particles of metal which easily wounded the skin softened by continuous wetting with the oil This played no small part in the etiology of dermatoses from the cutting oils

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CHAPTER XXIV

DERMATOSES CAUSED BY WAR GASES

NEARLY all of the war gases have manifold irritating and toxic effects on the body. They produce irritation, inflammation and destruction of mucous membranes and skin, the intensity of the effect depending on the concentration and time of exposure. The irritating properties of most of the war gases depend on the fact that they are cell poisons. The more toxic of these gases are chiefly used in wartime, although the lachrymators, or tear gases, and the sternutators, or sneeze gases, are used by the police to disperse crowds in times of peace.

Workers engaged in the manufacture of these chemicals are subject to the same hazards as are the soldiers against whom they are to be used in warfare. Despite the safety precautions observed in their manufacture such as totally enclosed processes, the wearing of protective clothing with frequent changes, the use of gas masks and compulsory shower baths, many workers in factories manufacturing war gases develop dermatitis from accidental contact with the gases or chemicals used in their manufacture. Leaks in pipes, the slightest carelessness in handling glassware and other apparatus, slight defects in protective clothing, and failure to remove or neutralize immediately accidental splashes often lead to severe dermatitis or even to systemic poisoning. Such accidents occur most frequently among new workers who do not realize the irritating and toxic effects of even the smallest quantity of these chemicals.

For example, in a small new chemical plant employing at its maximum operation not more than 10 men and equipped with modern totally enclosed apparatus for manufacturing only lachrymators and sternutators which are the milder types of war gases, Cole, Driver, *et al.* reported 24 severe cases of dermatitis in the course of one year. Examination of this plant by the authors disclosed that despite the workers' awareness of the poisonous properties of the chemicals and despite the fact that they were furnished with adequate means of protection, everyone employed in the plant had at one time or another contracted dermatitis due to carelessness and failure to observe the safety precautions.

Variations in sensitivity to the effects of these gases have been noted by a number of observers. Negroes are said to be less susceptible to their action than whites. Cole, Driver, *et al.* report that they have noted hypersensitivity induced by continued exposure. This hypersensitivity may be so intense that the mere presence in the same room with these chemicals may cause dermatitis. Animals are much less sensitive to the action of war gases than are humans. It is said that horses and dogs can withstand many hundred times the concentrations lethal to man.

Although, as stated before the war gases all have manifold toxic and irritating effects, they may be classified for medical purposes according to their chief physiological action as follows

1 Direct Poisons, without marked action on the skin or mucous membranes, such as hydrocyanic acid and carbon monoxide.

2 Vesicants, whose chief action is to produce blistering and necrosis of the skin and mucous membranes. Dichlorethylsulphide or mustard gas and chlorvinyl dichlorarsine, or lewisite are examples.

3 Lung Irritants which exert their chief lethal effects on the alveoli of the lungs by causing an exudation which fills the air cells similar in effect to pneumonia, the victim drowning in his own exudate. Phosgene and chlorpicrin are examples of this group.

4. Sternutators, or sneeze gases, which act chiefly on the upper respiratory tract, first produce sneezing and later bronchitis. Diphenylamine chlorarsine, diphenyl chlorarsine, and diphenyl cyanarsine are examples of these.

5 Lachrymators whose chief action is to irritate the conjunctiva causing pain swelling, and a profuse outpouring of tears resulting in temporary blindness. Chloracetophenone and bromacetone are examples of these.

Following is a brief description of the principal war gases and for further information the reader is referred to 'Chemicals in War by Augustin M Prentiss, First Edition, McGraw Hill Book Company Inc. New York and London 1937 "Leitfaden der Pathologie and Therapie der Kampfgaserkrankungen, by Otto Muntsch G Thieme Leipzig Germany 1932 and "Medical Aspects of Chemical Warfare by Edward B Vedder Williams & Wilkins Company Baltimore, Maryland 1925

Direct Poisons.—The direct poisonous agents which have no effect on the skin or mucous membranes will not be discussed. However cyanogen bromide and cyanogen chloride act on the skin

(*a*) **Cyanogen Bromide** (CNBr) —Cyanogen bromide known by Austrians as "Ce by the British as "C.B and by the Italians as 'Campilit," is made by treating potassium cyanide with bromine. It is a white crystalline solid melting at 52° C., and acts on the blood in a similar manner to hydrocyanic acid It has a lachrymatory effect and is not a strong skin irritant. Workers making it are subject to a skin hazard from bromine and Oppenheim describes brom-acne among workers who manufacture stench bombs containing xylol and hydrobromic acid The lesions consist in numerous pustules and furuncles of various sizes confined chiefly to the face and neck.

(*b*) **Cyanogen Chloride** (CNCl) —Cyanogen chloride, called "Vitrite " is a colorless liquid made by the chlorination of potassium cyanide It also has a toxic effect similar to that of hydrocyanic acid and an irritating action on the eyes and lungs.

Vesicants.—(*a*) **Dichlorethyl Sulphide** ($S(CH_2CH_2)_2Cl_2$) —Dichlorethyl sulphide is the best known of the vesicants. It is called

mustard gas by the British and American forces because of its characteristic odor. The French call it Yperite because it was first employed at Ypres and the Germans refer to it as yellow Cross or Lost which is a combination of the names of those who first recommended it for chemical warfare namely Lomel and Steinkoper. Mustard gas can penetrate ordinary clothing as well as rubber and leather producing serious burns of the skin. It clings to the clothing for a long time and is very persistent in its effects. Ioffe reports a case of dermatitis due to retained mustard gas in a man disassembling a defective mustard gas projectile fired seventeen years ago. Although the vapors are toxic even when inhaled in minute quantities there is no immediate effect other than sneezing. However in the course of an hour or two after exposure there develop severe conjunctivitis, erythema of the skin which goes on to blistering and necrosis and vomiting. Mustard gas is a transparent amber-colored oily liquid which boils at 217° C. In ordinary field concentrations it is almost odorless but in strong concentrations it smells like mustard or horseradish.

The Germans manufactured it from ethylene chlorhydrin and sodium sulphide forming thiodiglycol which was then chlorinated. This method of manufacture was attended with a minimum amount of danger to the personnel of the plants, since the health hazard in this process was confined to the last step chlorination. The method of manufacture employed by the Allies was simpler but more hazardous to the workers. They made it by the direct action of ethylene gas on sulphur monochloride. Health hazards in the manufacture of this chemical are great even under the most favorable conditions. Workers should be furnished with "mustard proof" *coveralls made of heavy fabric impregnated with chemicals which* neutralize mustard or made of the synthetic resin films which resist the passage of mustard. The clothing should be changed immediately if known contamination occurs and daily otherwise. Clothing made of the synthetic resin films can be decontaminated before being re-issued and impregnated fabric can be laundered and re-impregnated before being re-issued. Heavy rubber gloves, boots and aprons should be provided and gas masks should be worn by the workers making mustard. Everything which comes in contact with the liquid mustard must be neutralized immediately by dipping in a solution of calcium hypochlorite or by washing with acetylene tetrachloride which dissolves mustard or both. Care must be taken in decontaminating because the decontaminating chemicals themselves are skin irritants. This is especially true of acetylene tetrachloride. Only the education of the workers and the rigid enforcement of safety rules can prevent the frequent occurrence of dermatitis among those who work with mustard.

Mustard gas is only slightly soluble in water but it hydrolyzes into hydrochloric acid and thiodiglycol upon coming in contact with moisture. Flury and Gilchrist consider mustard gas to be a cell poison causing necrosis of the affected cells. Mustard gas is

insidious in its action the first symptoms appearing from two to six hours after exposure depending on the concentration of the gas the higher the concentration the shorter the latent period Skin lesions caused by mustard gas reach their maximum intensity forty-eight hours after exposure and then begin to abate (Schrafl) The lesions begin with erythema which soon develops into vesicles which at first resemble ivy poisoning except that they tend to occur in rings with erythema in the center of the ring The vesicles soon break down forming ulcers more or less deep depending on the amount of mustard to which the skin was exposed

The lesions in the respiratory tract consist of a fibrinous purulent pseudo-membranous inflammation which may result in pulmonary abscesses and gangrene

Observations made during the war and experimental studies show that there is marked individual susceptibility to the action of mustard gas. Marshall states that some individuals may be six hundred times as susceptible as others and that negroes are very resistant to its action.

The studies of Vedder showed that a drop of a 0.01 per cent solution in absolute alcohol placed on the flexor surface of the forearm produced a definite area of erythema twenty-four hours afterwards in 2 per cent of his subjects 25 per cent of his subjects proved to be very resistant to a 1 per cent solution while the remainder 73 per cent reacted to a 0.1 per cent alcoholic solution in twenty-four hours. Ferri tested 300 volunteers with mustard gas and found that the majority of them reacted to 0.2 per cent after twenty-four hours He also found that the sun-tanned skin was less sensitive than the untanned and that in the winter the effect of mustard gas appeared to be less than in the summer and that when the skin was hot and perspired its susceptibility to the effect of mustard gas was increased

First-aid for the prevention of burns from mustard gas in order to be effective should be administered within the first three minutes after exposure It consists of washing the parts with kerosene or gasoline to dissolve mustard gas and then washing with a strong solution of soap and hot water to remove the kerosene and mustard The parts should be rubbed dry and then rinsed with clear water Injuries produced by mustard gas heal very slowly and therefore are likely to become infected

The irritating concentration of mustard gas is 0.001 mg per liter for one hour and the minimum lethal concentration is 0.15 mg per liter for ten minutes Mustard gas can be destroyed by the action of alkalis and such oxidants as 5 per cent sodium hydroxide and calcium chloride but very strong oxidizing agents should not be used for neutralization because this may result in the production of a toxic product known as mustard sulphone Dichloramine T and sulphur dichloride or gaseous chlorine or a solution of sodium sulphide in water should be used to neutralize whatever mustard gas is on the clothing or skin According to Schrafl, washing the

parts with a 10 per cent solution of calcium hypochlorite followed by water is effective for neutralizing mustard gas if done ten minutes after exposure After this treatment an ointment consisting of petrolatum containing a 5 per cent solution of chlorine should be applied If vesicles have already formed they should be punctured with a sharp needle and then a wet dressing of a 1 to 2 per cent chloramine solution Dakin s solution or a 1 per cent potassium permanganate solution should be applied for a period of from ten to twenty minutes three or four times a day In between the applications of these dressings the lesions should be covered with boric acid ointment or vaseline The conjunctivitis should be treated by instillations of boric acid solution

Klarenbek states that glycerol can protect the skin from the action of mustard gas for a period of two or three hours This may be useful for prophylaxis among workers engaged in its manufacture

Solutions of calcium hypochlorite or of sodium carbonate should be kept in convenient places in factories where mustard gas is manufactured and the workers should be instructed to neutralize immediately accidental splashes on the clothes or skin.

Protective Clothing Against War Gases.—A protective agent against war chemicals of the vesicant group is said to consist of a soap such as aluminum palmitate or magnesium oleate in a solvent such as carbon tetrachloride or benzol which can be used to impregnate clothing to make it gas proof

Another protective agent is an organic chlorine compound such as chloramine incorporated into a wax or soap and dissolved in a suitable solvent which can be used to make clothing gas proof and also to neutralize the mustard which comes in contact with it A peroxide such as lead peroxide may be used instead of the organic chlorine compound

Stupnicki states that a fabric impregnated with chlorinated rubber a drying oil a non-drying oil and aluminum powder using toluol for a solvent gives good protection

Pirelli suggests a gelatin coated paper on which two layers of a varnish are placed consisting of blown linseed oil boiled wood oil a drier kauri resin in a petroleum solvent

Negri suggests the use of fabric gloves, lined with a fabric saturated with sodium perborate

All these impregnated fabrics must be re-impregnated from time to time The manufacture of some of them especially those containing chlorine compounds entails an industrial skin hazard

Clothing made of the synthetic resin films such as cellulose acetate will resist the passage of mustard for several hours and in the opinion of the authors has many advantages over impregnated fabrics.

Protective ointments against mustard have been proposed Some of these depend on their available chlorine content to neutralize mustard others contain agents such as gelatin which hydrolyzes mustard The value of these ointments is limited Those containing chlorine may themselves cause dermatitis.

It is interesting to note that Visser and Seldam have succeeded in inhibiting the formation of new growths from tar on mice by adding 0.5 per cent of mustard gas to the tar.

(*b*) **Chlorvinyldichlorarsine** ($CHClCHAsCl_2$) or lewisite has the same action as mustard gas, being a vesicant, lung irritant, and systemic poison. It is made by the action of acetylene on arsenic trichloride in the presence of aluminum trichloride. The resulting dark brown liquid is treated with hydrochloric acid and the oil obtained is fractionated into three chlorvinyl derivatives of arsenic dichloride known as primary, secondary and tertiary lewisite. The primary form is the most active. It is an oily, light amber liquid and boils at 190° C. It is insoluble in water but decomposes into hydrochloric acid and a non-volatile toxic vesicant ClCH:CH.As:O known as beta chlorvinylarsine oxide. Lewisite penetrates clothing just like mustard gas and its action persists even longer because of this non-volatile toxic vesicant decomposition product. The ulcerations of the skin, however, have a greater tendency to heal.

Lewisite acts more quickly than mustard gas. According to Charles Hederer and Mark Istin, when a drop of each is placed on the forearm of a man, the skin commences to redden at the end of thirty minutes with lewisite and only after two hours with mustard gas. Vesiculation appears at the end of thirteen hours with lewisite while it takes twenty-four hours for vesicles to appear with mustard gas. Thirty drops of lewisite allowed to remain on the skin of a man weighing 150 pounds produced fatal results. The minimum irritating concentration of lewisite is 0.0008 mg. per liter and the minimum lethal concentration is 0.120 mg. per liter for ten minutes.

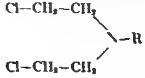
(*c*) **Methyl Dichlorarsine** (CH_3AsCl_2) is a vesicant and a toxic lung irritant. It is a colorless liquid, boils at 130° C. and is slightly soluble in water. It penetrates fabrics and has an action similar to mustard gas except that it is more rapid but less severe.

(*d*) **Ethyl Dichlorarsine** ($C_2H_5AsCl_2$), the German "Dick," has an odor of garlic. Its action resembles that of lewisite but differs from it in the fact that it is more irritating to mucous membrane and less irritating to the skin. It is said to cause inflammation of the nail bed.

(*e*) **Ethyl Dibromarsine** has an action similar to that of Ethyl Dichlorarsine.

(*f*) **Dibromethyl Sulphide** ($S(CH_2CH_2)_2Br_2$), the German "Bromlost," is a solid and has an action similar to mustard gas but less severe.

Other vesicant war gases have been made. Ward made war gases in which the sulphur atom of the "mustard" is replaced by a nitrogen atom to produce compounds of the general formula



The following are other compounds proposed for war gases

Formylchloridoxim
Cyanformylchloridoxim
Phosgenoxim
n Heptoxylvanillylamide
Kakodylcyanide
Tellurdiethyl
Trioxyfluoride

Lung Irritants —These substances exert their chief effects on the *alveoli of the lungs.* They cause edema of the lungs bronchitis and pneumonia the symptoms especially manifesting themselves upon exertion

(*a*) **Phosgene (Carbonyl Chloride)** ($COCl_2$) *known by the French as* "Collongite" by the Germans as "D-Stoff" and by the British and Americans as "C G" is the principal gas of this type used during World War I It is a colorless gas with a stifling odor resembling new mown hay It is manufactured by direct synthesis from chlorine and carbon monoxide When phosgene comes in contact with moisture it breaks down and liberates hydrochloric acid It is a skin irritant as well as a lung irritant Phosgene is encountered in industry as an intermediate in the manufacture of some dis-azo and anthraquinone dyes.

(*b*) **Dimethyl Sulphate** ($(CH_3)_2SO_4$) known by the French as "Rationite" is made by the action of fuming sulphuric acid on methyl alcohol It is a colorless oily liquid boiling at 188° C It combines with water to form sulphuric acid and has a corrosive action on the skin producing vesication and analgesia The latter may persist for six months. It is a lung irritant and lethal in the same concentration as phosgene 0.50 mg per liter for ten minutes. It is used in industry as a methylating agent for amines and phenols.

(*c*) **Trichlor Methylchloro Formate** ($ClCOOCCl_3$) the British "Diphosgene" French "Surpalite" and the German "Perstoff" is an oily liquid with a disagreeable suffocating odor boiling at 127° C which on contact with moisture breaks down into two molecules of phosgene

(*d*) **Chlorpicrin or Nitrochloroform** (CCl_3NO_2) is a colorless oily liquid In addition to being a lung irritant it is also a lachrymator Kleinanow and Christin report that it is used for disinfecting and exterminating purposes and they cite occupational skin hazards from its use

(*e*) **Phenyldibromarsine** ($C_6H_5AsBr_2$) is a yellowish liquid which boils at 285° C It has a powerful vesicant action and is probably the most toxic lung irritant the minimum lethal concentration being 0.20 mg per liter for ten minutes.

(*f*) **Phenyldichlorarsine** ($C_6H_5AsCl_2$) the German "Blue Cross" and French "Sternite" is a clear viscid liquid which boils at 252° C It is insoluble in water but soluble in the usual organic solvents It is a marked vesicant as well as a sternutator A concentration of 0.26 mg per liter for ten minutes is fatal Phenyldichlorarsine

used in a solution of petroleum distillates in the strength of about 1 per cent is an efficient wood preservative. It has fungicidal properties because of the arsenic groups present.

Sayers and Dudley carried out experiments concerning its skin irritating properties and found that 1 drop of a 1 per cent solution in oil caused a severe reaction on the human skin after forty-eight hours. They stated that removing a 1 per cent mixture in oil with soap and warm water within thirty minutes after contact with the skin materially reduced the vesicant effect. They suggested that a salve containing equal parts of petroleum jelly and freshly precipitated basic ferric hydroxide be spread over the skin to protect workers exposed to this chemical.

STERNUTATORS

Sternutators, or sneeze producers, are solids and are dispersed as fine dusts by heavy explosive charges. They penetrate ordinary filters used in gas masks and act on the ends of the sensory nerves causing, even in low concentrations, acute pain and irritation of the mucous membranes of the eyes, and the respiratory tract. If the exposure is not too long, the symptoms disappear in a few days without leaving any after effects.

The sternutators act by forming hydrochloric acid in the presence of moisture and if they are used in sufficient concentration can cause dermatitis. Exposure to high concentrations for a long time causes serious pulmonary damage.

(a) **Diphenyl Chlorarsine** ($((C_6H_5)_2AsCl)$ the German "Clark I" is made by acting on chlorbenzene and arsenic trichloride with metallic sodium. This forms triphenylarsine which is heated under pressure with more arsenic trichloride. It is a white crystalline solid which melts at 45° C. It is insoluble in water but rapidly decomposes in the presence of moisture to yield hydrochloric acid and phenylarsenic oxide which is also toxic. It irritates the respiratory tract, conjunctiva, and skin. It causes sneezing, coughing, choking, bronchitis accompanied by headache, pains in the ears, jaws, teeth and chest, nausea and vomiting. Unsteady gait, vertigo, weakness, trembling and loss of consciousness follow. It irritates the mucous membranes in as low a concentration as 1 part in 25,000,000 and the minimum lethal concentration is 1.50 mg. per liter for ten minutes.

Most of the cases of dermatitis reported by Cole, Driver, *et al* were due to diphenyl chlorarsine. Gillert described a case of dermatitis which developed in a chemist three days after exposure to this substance in spite of the fact that he immediately washed and applied a solution of calcium chloride.

(b) **Diphenyl Cyanarsine** ($((C_6H_5)_2AsCn)$ the German "Clark II" is made by the action of sodium cyanide on diphenyl chlorarsine. It is a colorless crystalline solid which melts at 31.5° C. and has a similar but more powerful action than diphenyl chlorarsine.

(c) **Diphenylamine Chlorarsine** ($(C_6H_4)_2NH.AsCl$) the American "Adamsite" is made by the action of diphenylamine on arsenic trichloride. It is a yellow crystalline solid melting at 195° C. and is insoluble in water but hydrolizes in the presence of moisture yielding hydrochloric acid and a toxic oxide. It is odorless and has the same effect as diphenyl chlorarsine but to a lesser degree.

LACHRYMATORS

The lachrymators act quickly and at low concentrations affect chiefly the eyes. However, their action is temporary. They cause secretion of tears and conjunctivitis with swelling and closing of the lids resulting in temporary blindness. They do not affect horses, mules, and dogs nearly so much as they do humans. Heavy concentrations of the lachrymators for long periods of time can cause injury to the skin and mucous membranes and may even result in death. The minimum irritating concentration of some of these substances is as low as 1 part in 100 000 000.

(a) **Brombenzyl Cyanide** ($C_6H_5CHBrCN$) known as "C.A." in America and as "Chamite" in France, is a yellow white crystalline solid which melts at 25° C. It has an odor of soured fruit. It is prepared by the chlorination of toluene to form benzyl chloride which is then reacted with sodium cyanide to form benzyl cyanide and brominated by the action of bromine vapor. This substance will cause blistering if dropped on the skin. It has a minimum irritating concentration of 0.00015 mg. per liter and a minimum lethal concentration of 0.90 mg. per liter for thirty minutes.

(b) **Chloracetophenone** ($C_6H_5COCH_2Cl$) known in America as "C.N." is made by chorinating acetic acid to form monochloracetic acid, which is further chlorinated with sulphur monochloride and chlorine gas to form chloracetyl chloride, which is treated with benzene in the presence of aluminum chloride. It consists of colorless crystals melting at 59° C. and has an odor of apple blossoms. It has an action like that of brombenzyl cyanide. Cole, Driver *et al.* report dermatitis among workers who manufacture it. Dietel reported that chloracetophenone which was used as a filler in pistol ammunition had caused dermatitis.

(c) **Ethyliodo Acetate** ($CH_2ICOOC_2H_5$) the British "SK" is a colorless oily liquid which boils at 180° C. and is made by the action of ethyl chloracetate on potassium iodide.

(d) **Bromacetone** (CH_3COCH_2Br) the American "BA," French "Martinite," and German "B-Stoff" is produced by the direct action of bromine on acetone. It is a colorless liquid which boils at 135° C. It produces painful blisters when it comes in contact with the skin. The vapor may produce only a slight and transient dermatitis but the liquid causes burns.

(e) **Xylyl Bromide** ($C_6H_4CH_3CH_2Br$) the German "T-Stoff" is prepared by the direct bromination of xylene.

(f) **Benzyl Iodide** ($C_6H_5CH_2I$) the French "Fraisinite" is made by

the action of benzyl chloride on potassium iodide. It is a white crystalline solid melting at 24° C.

(*g*) **Ethyl Bromacetate** ($CH_2Br\,COOC_2H_5$) is made by the action of bromacetic acid on alcohol. It is a transparent liquid which boils at 168° C.

(*h*) **Phenyl Carbylamine Chloride** ($C_6H_5CNCl_2$) is made by chlorinating phenyl mustard oil. It is a transparent liquid boiling at 210° C. It is not only a lachrymator but also a lung irritant and skin irritant.

(*i*) **Benzyl Bromide** ($C_6H_5CH_2Br$) the French "Cyclite," is made by the direct bromination of toluene. It is a liquid which boils at 201° C.

(*j*) **Acrolein** (CH_2CHCHO) the French "Papite," is made by distilling glycerine in the presence of potassium bisulphate. It is a clear greenish yellow liquid with a pungent odor and boils at 52° C. This substance is not only a lachrymator but also a lung irritant and vesicant.

(*k*) **Brom-methyl Ketone** ($CH_3CO\,CH_2Br\,CH_3$)

(*l*) **Chloracetone** (CH_3COCH_2Cl) the French "Tonite," and

(*m*) **Iodoacetone** (CH_3COCH_2I) the French "Bretonite" are also lachrymators.

The action of the lachrymators can be neutralized by washing the parts with a warm solution of sodium carbonate and by instilling boric acid solution into the eyes.

It should again be emphasized that all of the war gases described here are more or less powerful skin irritants. Hanzlik and Tarr have systematically studied the irritant action of many war compounds and find that arsenic trichloride, bromine trifluoride, chlorisonitrosoacetone, dinitrochlorbenzol, iodinepentafluoride, selenium bromide, dichlorethylselenide, titaniumtetrachloride, and di-isothiocyanide-methylether in addition to the compounds described above are all severe skin irritants.

There are also many chemicals which are added to gas shells for technical reasons which are in themselves skin irritants, such are chlorbenzene, ethylene dichloride, and other solvents. The chemicals used to create smoke screens, such as sulphur trioxide, stannic tetrachloride, and chlorsulphonic acid, may also be skin irritants. Arzt describes 3 cases of occupational dermatitis caused by chlorsulphonic acid which is also used in the manufacture of saccharin. The contents of incendiary shells such as phosphorus, carbon disulphide, nitrous and nitric compounds may also be skin irritants and the combustion products and gases formed by the explosion are also irritants.

PREVENTION OF DERMATOSES FROM WAR GASES

Prevention of industrial dermatitis in the manufacture of war gases consists in having totally enclosed apparatus wherever possible, the education of the workers concerning the toxic effects of

the materials and the rigid enforcement of all safety precautions such as absolute cleanliness of the plant daily change of work clothes, immediate changing of clothes when they are splashed immediate neutralization of all articles exposed to irritating chemicals (alkalis and oxidants will decompose and render harmless most of the war gases) the wearing of adequate gas-proof protective clothing and the use of gas masks. The filters in the gas masks should be especially prepared For instance a gas mask filter for preventing the passage of irritating or poisonous gases invented by Walter Bauer consists of a ground substance coated with a film containing polymerizates of an ester and vinyl compounds or their homologs Substances yielding chlorine and basic substances may be added Thus a 25 per cent solution of the polymerized ethyl ester of acrylic acid is treated with 5 per cent zinc oxide and 5 per cent $ClNH_2$ and poured on a slab to produce a film 0.5 mm. thick. This film is pressed between two layers of fabric at 70° C. to form a poison gas filter * Other safety precautions are washing of the hands and face before eating the prohibiting of eating in the work rooms and compulsory supervised shower baths after work. There should be provided in plain view and readily accessible solutions of calcium hypochlorite sodium carbonate and acetyl tetrachloride to neutralize immediately any accidental splashes of the irritants and the first-aid station should contain a supply of Dakin s solution or 1 per cent potassium permanganate solution for the treatment of any worker unprotected and exposed to the action of these gases and chemicals

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CHAPTER XXV

DERMATOSES CAUSED BY FURS

BEFORE hides can be used for fur they must be chemically treated so that they will last. This process is known as fur dressing and such substances as oils, salt, alum and extracts of certain trees are used for this purpose. Formerly such treatment occupied a period of weeks, whereas modern fur dressing is completed in a few days

Pelts are usually received by fur dyers in a dried and stretched condition Furs of Chinese dogs are received dried and powdered with a composition of rice powder alum and salt which is quite irritating to the skin and mucous membranes Large skins such as bear and seal are received salted and in a moist condition. Dry furs are first softened and if greasy cleaned of excess fat by "scraping or "beaming with a large two-handled knife. Dried skins are softened by soaking in water or brine. Sometimes solutions of borax and formic acid are used for softening Delicate furs of small animals are sometimes softened by revolving them with moist sawdust in an enclosed drum Sometimes the fleshy side of the pelt is brushed with a solution of brine. In this latter operation the hands of the workers may become chapped and cracked especially in cold weather from the action of the brine. Skins are further softened by placing them in a machine called a tramping machine or a "kicker"

After the softening process they are "fleshed" This consists in removing undesirable portions of fat by pulling the fleshy surface of the skin back and forth over a large knife called the fleshing knife During the busy season fleshers have their finger-nails worn down to the quick as a result of friction from pulling the skins over the fleshing knife

A number of tanning processes are used depending on the kind of skin. The salt acid tan consists of a 10 per cent solution of salt to which a small amount of sulphuric acid has been added The solution can be applied either by a brush to the fleshy side of the skin or if the hairs will stand it the whole skin can be immersed in the solution Formic or lactic acid may be used in this tanning solution instead of the sulphuric acid

Mineral tans consist of a solution of alum and salt The skins can be tanned by brushing or by immersion Workers who brush these irritant solutions on the skins may develop dermatitis if not properly protected by rubber gloves

Chrome tanning is necessary when certain aniline dyes are to be used because the chrome also acts as a mordant to fix the dye in the fur It is also desirable for pony and rabbit skins. Chrome tans usually consist of about a 7 per cent solution of chrome alum to which about 4 per cent of washing soda is later added. Men who

work over the vats where chrome tanning is done sometimes develop dermatitis from the chrome tanning solution

Small skins such as marten mink, ermine etc are tanned by rubbing the fleshy side of the skin with oil. Seal oil Neats Foot oil olive oil castor oil cottonseed oil and sulphonated oils are used for this purpose

Solutions of formaldehyde and combinations of the above tanning agents are also used for the skins of small animals The tanning solutions are usually rubbed into the fleshy side of the pelt with hand brushes and dermatitis may occur on the hands of the brushers from tanning agents After tanning the pelts are washed in water hydro-extracted and dried

The skins are now ready for stretching This is done by softening them with oil brushed into the fleshy side and then pulling them over a dull knife or pinning them to stretching frames Pin pricks of the fingers and hands are frequent during this operation and infections of these wounds sometimes occur Long-haired furs after stretching are combed and beaten. Skins such as wolf and ox are treated by a number of men who hold portions of the skin with one hand to stretch it and beat the pelt with a stick held in the other hand In this process there is considerable fur dust set afloat in the air so that asthma and catarrh of fur beaters and combers is fairly common. Modern machinery has been devised for beating and the machines are equipped with suction to remove dust and hairs that are loosened by the beating process The smaller fur dressing and dyeing shops are not equipped with such machinery

Some skins are given a final cleansing by revolving them in a drum containing hardwood sawdust After this process the skins are caged that is they are placed in other drums with sides made of wire mesh and revolved to shake out the sawdust The cages are usually situated in enclosed rooms equipped with exhaust apparatus to remove the sawdust

Valuable furs which possess coarse or top hairs have these coarse hairs removed by special machines called unhairing machines Less valuable skins such as rabbit are sheared to make all the hairs even. Unhairing and shearing machines are usually provided with exhaust ventilation to suck up the cut hairs Nevertheless asthma and catarrh occur among the workers on these machines as a result of inhaling the fur dust which the vents do not remove.

The principal skin hazards among fur dressers are dermatitis from preservative powders used on pelts especially on Chinese dog pelts dermatitis resulting from hypersensitivity to animal dander dermatitis resulting from the chemicals used in the tanning solutions. Fungus infections also occur with unusual frequency on the hands of workers with raw furs

Furs are dyed to improve the color to hide defects to imitate the furs of rare animals and to produce novel effects Matching the color of different skins is called blending

Before furs are dyed they must be killed and mordanted

"Killing" consists in removing the layer of fat which covers the individual hair and which would prevent the dye from penetrating the hair. This is done by immersing the skins or brushing them with a weak solution of an alkali such as sodium hydroxide, sodium carbonate, ammonia, or lime to dissolve and remove the grease. They are then washed in water to remove the alkali, then in a weak acid solution to neutralize any alkali remaining, and finally washed in water to remove the acid, and hydro-extracted.

Mordanting is necessary in order to have the dye adhere to the fur. Some of the mordants used in fur dyeing are aluminum sulphate, aluminum acetate, ferrous sulphate, ferrous acetate, copper sulphate, copper acetate, chrome alum, chromium acetate, sodium and potassium bichromate.

Sometimes the "killing" and the mordanting is done at the same time by using an alkaline mordant. Workers engaged in "killing" and mordanting wear long rubber gloves, boots and aprons. Despite these precautions, however, dermatitis occurs among workers thus engaged either from splashes of these irritating chemicals or from hypersensitivity to them.

Mineral colors can be used on furs, especially on such furs as white rabbit. Thus a solution of lead acetate is brushed on the fur and allowed to dry. Then a solution of ammonium sulphide is brushed on and the skin again allowed to dry. This causes a brownish color to develop as the result of the precipitation of lead sulphide. Alternate brushings can result in a very dark brown. This is called progressive dyeing with lead salts. Fur dyers using lead should be periodically examined for symptoms of lead poisoning, as well as for symptoms of hydrogen sulphide poisoning, because this gas is given off in the process.

Potassium permanganate is also occasionally used to produce brown shades.

Vegetable dyes are divided into two classes, those containing tannin, and the dye woods proper.

The tannin-containing dyes are used in conjunction with iron salts to produce grayish to black shades. The principal ones are:

1. *Nutgalls*, ball shaped excrescences produced on oak trees by the puncture of the female gallwasp; also on the leaves and stalk of a species of sumac by the puncture of the plant louse. Nutgalls contain 50 per cent to 60 per cent of tannic acid and about 4 per cent of gallic acid.

2. *Sumac*, the leaves, small twigs and stems of Rhus Coriaria are used for dyeing. They contain 15 per cent of tannic acid.

3. *Chestnut Extracts*. This is made from the chestnut oak and contains 8 per cent to 10 per cent of tannic acid.

The dyewoods proper are:

1. *Logwood*.—Or campeachy wood, which grows in the West Indies and in Central and South America. It contains a substance hematoxylin, which is converted into hematein in the presence of air. Logwood gives different shades with different mordants. Iron

mordants give grayish to black copper and chrome mordants give green blue to black aluminum mordants give a violet shade and tin a purple shade

2. *Fustic Yellow Wood*—Or Cuba wood also grows in the West Indies Central and South America and gives colors varying from olive to a bright yellow with different mordants. It contains two coloring matters morin and morin tannic acid

3 *Brazil Wood*—Or redwood contains brazilin a colorless substance which is oxidized to red brasilein

4. *Quercitron*—This is the inner bark of quercus tinctoria. It contains two coloring matters quercetrin and quercetin It gives a yellow color

5 *Cutch*—This is the dried extract obtained from a species of acacia grown in Bombay Bengal and Gambier It is used for dyeing browns and contains two coloring matters catechin and catechu-tannic acid

6 *Turmeric*—Is the underground stem of the Curcuma Tinctoria and contains a color principle called Curcumin

By combining these wood dyes with suitable mordants all shades can be produced on furs.

The wood and vegetable dyes are usually used for the dyeing of expensive furs, especially black persian lamb broadtail and caracul. The skins are immersed in the dye bath kept there for a while taken out and exposed to the air for the color to develop The process is then repeated until the desired shade is obtained

Hypersensitivity to these dyes may occur but dermatitis is a rare occurrence among dyers who use only vegetable dyes and it is also rare among the wearers of vegetable-dyed furs.

Synthetic dyes depend upon oxidation of the dye on the fur to produce their color Anilne black is usually dyed as a top color and is brushed on the top third of hairs which have been given a ground color with another dye Oxidizing agents such as sodium chlorate ammonium vanadate copper sulphate and sodium bichromate are used to develop the black. Diphenyl black (para-aminodiphenylamine) and para-amido-phenol are also used for producing black on furs

In the year 1888, Erdman a German chemist, patented a method of dyeing which consisted of using a solution of paraphenylenediamine or similar bases (such as dimethyl-paraphenylenediamine and the naphthalene diamines) and caustic soda and then oxidizing with a solution of hydrogen peroxide He also stated that these substances were not injurious and could be used to dye human hair The patent was extended to include certain oxy and amido oxy compounds like para-amido-phenol hydrochloride and ortho-amidophenol. By using various mordants with these dyes a great range of colors were obtained As a result of this patent, there was put on the market under the name of Ursol a number of fur dyes for producing different shades. A short time after they began to be used the workers handling them developed dermatitis, conjunctivitis

asthma and intestinal disturbances attributed directly to these fur dyes. Investigations by chemists and physicians led to the opinion that it was the intermediate oxidation product quinone-di-imine which was the actual cause of the dermatitis and the asthma. Paraphenylenediamine $C_6H_4(NH_2)_2$ when pure occurs as colorless crystalline lumps which rapidly turn brown when exposed to the air. It can be prepared by the treatment of para dichloro benzol with ammonia under pressure or by the reduction of paranitranaline or by the reduction of amido-azo-benzol.

In the oxidation of paraphenylenediamine the first step is the formation of quinone-di-imine $NH{:}C_6H_4{:}NH$ which has a sharp penetrating odor and produces violent local irritations of the mucous membranes and skins of sensitive individuals. Through breathing the dust of paraphenylenediamine quinone-di-imine is formed in the respiratory tract. It does not long remain as such but is soon oxidized and there results a substance known as Bandrowski's Base which has less irritating powers. The reactions may continue further producing more complicated but less irritating products.

Sometimes furs are given a ground color with a vegetable dye and then a top color with an oxidation dye. When this is done hydrogen peroxide or other rapid oxidizers are not used because they would also act as bleaching agents for the ground color. Sodium carbonate or sodium bicarbonate is used instead. These act by absorbing oxygen from the air and slowly supplying it to the oxidation dyes used for topping. In this method of dyeing it takes much longer for the oxidation dye to be completely oxidized but the ground color is not impaired. The oxidation may not even be complete after the fur is sold. During all this time the irritant intermediates of the oxidation process such as the quinone-di-imides are being formed and may irritate hypersensitive wearers of these furs or may sensitize previously immune wearers to their action.

By improving the dyes and the methods of dyeing so that no unoxidized or oxidized dye is left on the hairs, which can come off when the furs are brushed or beaten, and by having the workers wear protective clothing in the form of rubber aprons, gloves and boots, the number of cases of dermatitis among workers with synthetic fur dyes has greatly diminished. The use of mordants to fix the dye on the fur and the development and application of devices to prevent the formation and circulation of dust in the handling of the dye, as well as the use of dilute solutions of paraphenylene diamine, have helped lessen the health hazards of handling these synthetic fur dyes. Thorough washing of the dyed skins in water and repeated drumming to remove all the excess dye has also helped to diminish the number of cases of dermatitis among the wearers of synthetically dyed furs.

Basic, acid, chrome and vat dyes are also used to a lesser degree in the dyeing of furs. The basic dyes are fugitive, the acid colors are a little more enduring. The chrome colors and the vat dyes, however, give fast shades.

Blending is the art of making skins of different shades match each other so that a garment of uniform color may be produced. Sables, martens, chinchillas, minks and other rare furs are blended. Each skin requires individual attention and treatment. The dye solution is applied by means of fine brushes and feathers to the tips of the hairs until the proper shade is obtained. Blenders are more exposed to dyes than ordinary dyers and unless they wear proper protective gloves, boots, and aprons, they are likely to develop dermatitis or asthma from paraphenylenediamine.

The largest fur dyeing plant studied by the authors employed about 700 workers, most of whom were engaged in dyeing muskrat skins to imitate "Hudson" seal. This is done by immersing the "killed" chrome mordanted skin in a solution of paraphenylenediamine, ammonia and peroxide to give a ground color and after drying and repeated drummings, "topping" the hairs with aniline black. "Topping" is done by rubbing into the upper portion of the fur by means of revolving brushes, a solution of aniline salt (aniline oil neutralized with hydrochloric acid to form the hydrochloride), potassium chlorate, and potassium bichromate. The fur is then dried and repeatedly drummed. Four cases of dermatitis due to paraphenylenediamine were found among these workers during the course of this study. All 4 of these cases gave positive patch tests with a 2 per cent solution of paraphenylenediamine and negative reactions to turmeric, logwood, pyrogallic acid, iron liquor, nutgall and tannic acid which they also handled.

The most striking condition found in this plant was on the finger nails of the men working on the fleshing knives and on the pulling knives. These men grasped the moist skins and pulled them over large curved knives, stretching them in order to remove the excess flesh from the larger skins. The finger-nails of these men were worn down and the matrix was thick and tough. The fleshers who worked with the freshly tanned skins which were still wet with the acid tanning solution were chiefly affected. The matrix of the nail was tough and scaly. All of the fleshers suffered from this condition to some degree during the busy season. In the slack season, the nails grew back.

In a factory employing an average of 300 men, where Australian rabbits were dyed with paraphenylenediamine, para-amido-phenol and ortho-amido-phenol to resemble beaver and seal in a manner similar to the dyeing process described for muskrat, 9 cases of dermatitis occurred in two years (Fig. 44). Two workers were also found who had asthma due to hypersensitivity to paraphenylenediamine at the time the present study was made.

In another factory employing 40 workers, where synthetic dyes were used, 2 cases of dermatitis and 1 case of asthma due to paraphenylenediamine were found.

In three smaller plants, employing altogether 130 men, 2 cases of dermatitis due to paraphenylenediamine were found.

In one factory employing about 100 workers, where synthetic dyes were not used there were no cases of dermatitis or asthma

Six cases of dermatitis occurring in various small fur dyeing establishments and supposedly due to fur dyes were especially studied All of these cases had erythematous papular vesicular eruptions on the hands and scaling between the toes. All 6 were patch tested with a 2 per cent solution of paraphenylenediamine for forty-eight hours. Four gave positive reactions and 2 negative reactions.

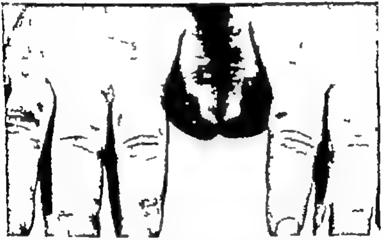

FIG. 44 —Occupational dermatitis and asthma in furrier due to amine dyes. Positive patch tests to P-phenylene diamine N W dichloroquinone diimid, N-chloroquinone diimid. (Case of Dr B M Kesten, Vanderbilt Clinic Columbia University New York.)

Of the 2 who did not react to the paraphenylenediamine 1 was not exposed to it in the course of his work since he dressed only raw furs. His condition was undoubtedly occupational because it got well when he stayed away from his work for a week or two and promptly reappeared when he returned He pulled stretched and combed the skins of fox, wolf skunk possum marten lynx and weasels and he probably was sensitive to the dander or preservative powder on some of these furs. (Fig 45) He did not return for further patch tests. The other case responded to treatment with Whitfield's ointment

Mycotic infections of the hands and feet were found to be more prevalent in the fur dyeing industry than in other industries where animal hair or hides are not handled Many of these were thought by the workers to be dermatitis due to the dyes but negative patch tests with the dyes did not substantiate this.

The chief skin hazards in fur dyeing establishments were found to be the synthetic oxidation dyes, the mordants, especially the bichromates and bleaching solutions used by the workers at the end of the day's work to remove dye from their hands Less than

1 per cent of the workers employed were found to be suffering from dermatitis due to the dyes used in their occupations This did not however represent the actual percentage of workers sensitive to these substances, because the workers who developed dermatitis from dyes or chemicals were either discharged or had left the plant so that those who remained were more or less immune

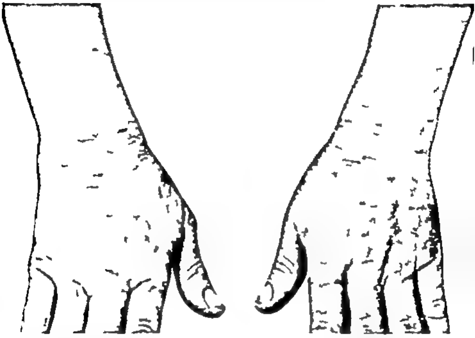

FIG 45 —Furriers dermatitis due to preserving powder on raw dried furs.

Prophylaxis of dermatitis among furriers should consist of

1 The selection of only such new employees that give no history of sensitivity to the dyes and chemicals with which they come in contact.

2 Periodic examinations and the removal to other occupations of those found to be suffering from occupational dermatitis.

3 Emphasis should be placed on cleanliness and facilities in the form of shower baths should be provided for the workers after the day s work. Bleaches and strong alkali soaps should not be used for removing the dye from the hands.

4 Proper washing and drumming of furs to remove the excess of dye.

5 The installation of modern machinery equipped with suction hoods and forced draft devices to remove hair dust and fumes from the rooms.

6 In the dye house and dye kitchen where dyes and salts of lead copper and chromium are weighed and cooked the workers should

be safe-guarded by ventilating hoods, gas masks and protective clothing

7 Protective clothing in the form of rubber gloves, rubber boots, and aprons should be provided to the workers around the dye and mordant vats and where acids, alkalis and corrosive chemicals are used.

8. In the receiving rooms where irritating powders are given off by the skins dressed in Asia and other foreign countries, the workers should wear respirators and wherever possible, the handling of these skins should be done under forced draft ventilation to keep the room free from dust.

9 In the dye rooms the floors should be turtleback to allow drainage and prevent the accumulation of pools of dye and water Dye vats should be sunk into the floor and surrounded with a moat to drain off splashings

10. The unhairing and the shearing rooms should not only be well ventilated but a forced draft adequate to remove the hair should be provided over each machine.

DERMATITIS AMONG THE WEARERS AND HANDLERS OF FURS

Dermatitis has been caused by wearing and handling of furs. Medical literature contains articles describing such cases. A special report was made in England on an outbreak of dermatitis occurring from dyed furs.*

Combined statistics of the Labor Commissions of New York and Ohio showed that in 1934, out of about 1 600 cases of occupational dermatitis reported to the commissions 29 were attributed to the handling of dyed furs. These cases occurred among fur salesmen fur cleaners, fur garment makers and fur ironers.

In cleaning furs it is possible for the dye to come off the fur through the action of the cleaning fluids and to irritate sensitive workers. In beating the furs to remove excess dye or dust, the particles of dye which come off the fur may also cause dermatitis. In ironing furs the heat of the iron may cause the dye to come off in the steam It is also possible if the iron is too hot to decompose the dye into its intermediates which may cause dermatitis.

Among fur wearers, the rubbing of the coarse stiff hairs of certain furs against the skin of the neck or wrists may cause a dermatitis due entirely to friction Dermatitis may also be caused by sensitivity to the fur itself or to the chemicals used in dressing tanning and dyeing † (Fig 40)

When furs are worn the non-hairy side of the pelt is covered by

* See Reports on Public Health and Medical Subjects, No. 27 Report of an Inquiry into the Occurrence of Dermatitis Attributed to the Wearing of Fur Collars, 1923-1925 by Alfa O Parsons, M.R.C.S Ministry of Health, London.

† Dermatitis from fur dyes, and for that matter from hair or fabric dyes, is due primarily to personal idiosyncracy The garment causing the dermatitis in the sensitive patient may be safely worn by the large majority of normal people.

a lining and only the fur itself comes in contact with the skin. This eliminates to a large extent the possibility of dermatitis due to the chemicals used for dressing or tanning. Most of these chemicals are taken up by the leather itself, very little being left on the fur.

The chemicals used in "killing" (weak alkalis) are neutralized and washed away with water. The chemicals used as mordants and the dyes are located on the hairs and are the chief causes of dermatitis resulting from wearing furs.

Fig. 46.—Dermatitis due to poorly dyed fur collar. Skunk collar dyed black with paraphenylenediamine. The dye could be easily rubbed off. Patch test with dyed fur showed positive.

For the mordants and dyes to cause dermatitis they must be so poorly applied to the fur that they readily come off or dissolve in the skin secretions of a sensitive wearer or handler. Such conditions are present only in poorly dyed and insufficiently washed and drummed furs called "dirty furs" in the trade. Moreover sensitivity to these substances must be present.

That not many such poorly dyed skins are worn or handled by sensitive individuals is shown by the very few cases of dermatitis among the millions wearing furs. The skin may be sensitive to any of the mordants and dyes, but the chrome mordants and synthetic oxidation dyes, paraphenylenediamine, paramidophenol and ortho-amido-phenol, have been the chief causes of dermatitis.

G H Percival concluded that oxidation of these dyes lessened their powers of irritation, that the dermatitis produced by them depends on an allergic state and is idiosyncratic in nature and that the percentage of allergic individuals is small

Alfred Muller succeeded in sensitizing patients by repeated applications of paraphenylenediamine and in a few instances succeeded in obtaining passive transfer of the sensitivity

John T Ingram concludes that 4 per cent of normal people have a natural idiosyncrasy to paraphenylenediamine

H E. Cox, after examining 210 furs alleged to be dyed furs which had caused dermatitis found that 37 of them were not dyed and that these 37 came from 17 different animals He concluded that if a dyed fur were properly washed so that all free paraphenylenediamine was removed no dermatitis could result He also stated that paraphenylenediamine penetrated the dead skin but not the living skin under normal conditions. He explained that irritation was caused by the abnormal penetration of the skin by paraphenylenediamine followed by a local reaction with certain constituents of the blood.

Dermatitis from wearing furs has usually occurred with furs dyed lighter than black so that it seems that the depth of the color of the fur is important in the etiology of dermatitis. This accords with the fact that the partially oxidized dyes cause dermatitis. The more complete the oxidation of the dyes the deeper is the color

Among fur wearers the dermatitis begins around the neck chin chest, face and wrist and in severe cases may spread to other parts of the body The first symptoms are itching and redness which may begin anywhere from a few hours to weeks after wearing the fur The reasons why the dermatitis does not develop immediately are first that the fur may have to be wet by rain water or perspiration before the irritating chemical is dissolved and wets the skin of the wearer and second that a certain period of contact is necessary before the wearer becomes sensitized to the dye If the wearer is sensitive before the fur is worn then the dermatitis may develop in a few hours after donning the garment whereas if sensitivity is acquired by wearing the garment several weeks may elapse before dermatitis develops.

The dermatitis may consist only of pruritus and erythema or may progress to papules edema vesicles and moist eczematoid eruptions followed by desquamation. Secondary infections of the lesions may occur Symptoms of systemic poisoning although extremely rare have been reported The authors have not seen such cases

The symptoms in the great majority of cases subside if the furs are not worn and the uncomplicated eruption will respond to simple treatment The cases of chronic eczema with poly-sensitivity alleged to have been caused by fur dyes, which persist even though the furs are no longer worn are rare and it is extremely difficult to prove that the furs are the original exciting cause

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The dermatitis may consist only of pruritus and erythema or may progress to papules, edema vesicles and moist eczematoid eruptions followed by desquamation Secondary infections of the lesions may occur Symptoms of systemic poisoning, although extremely rare have been reported The authors have not seen such cases

The symptoms in the great majority of cases subside if the furs are not worn and the uncomplicated eruption will respond to simple treatment The cases of chronic eczema with pigmentation alleged to have been caused by fur dyes, which persist even though the furs are no longer worn are rare and it is extremely difficult to prove that the furs are the original exciting cause

The prevention of dermatitis due to wearing furs is largely in the hands of the fur dyers. Weak solutions of dyes should be used they should be properly oxidized the excess dye should be washed off and after drying the skins should be repeatedly drummed until no more dye comes off. Dirty furs should not be permitted to leave the dyer.

When it is suspected that furs are the cause of dermatitis the following facts must be ascertained and considered in order to confirm the diagnosis

The recurrence of a previous skin disease must be ruled out

The presence or absence of other skin diseases, especially dermatomycosis and its allergic manifestations should be ascertained

Skin or mucous membrane allergy to other substances must be considered

Food allergy as a cause of the eruption should be investigated

The time relations between the outbreaks of the dermatitis and the wearing of the fur must be ascertained

The location and appearance of the eruption. An eruption due to the fur should begin at the site of contact of the fur with the skin. It should have the morphology of a contact dermatitis.

Then perform patch tests on normal skin near the eruption with three 1 inch square pieces of the suspected fur. Moisten one piece with the perspiration of the patient wet the second piece with a synthetic perspiration having an acid reaction and the third piece with a synthetic perspiration having a slightly alkaline reaction. Place these patches on unaffected portions of the skin near the site of the eruption with the hairy side of the fur next to the skin. Allow them to remain on for as long as five days unless the patient complains of symptoms of irritation before that time and then remove the patches. If no reactions are present and none develop within a few days after removal of the patches (delayed reactions) the patient is not sensitive and the fur is not the cause of the dermatitis. If a reaction develops ascertain where the fur was dyed and obtain samples of similar fur in the different stages of manufacture that is, undressed dressed tanned mordanted and dyed and perform patch tests on the patient with each of these samples. This will locate the process in which the irritant is introduced into the fur.

Further testing with the chemicals used in that process and in the dilutions used in treating the fur will reveal the actual chemical causing the dermatitis. For instance if there is no reaction to any of the patches except the dyed fur then it is known that the patient is not hypersensitive to the fur itself nor to the chemicals used for dressing tanning and mordanting. Further patch tests must be done with pieces of the mordanted fur dyed with each of the various dyes which had been used on the finished fur. In applying these individual dyes to the fur pieces for the purpose of making the patch tests, they should not be washed or drummed and should be applied to the patient moistened with the natural perspiration as well as with synthetic acid and alkali perspiration.

Patch tests yield best results if performed on the patient while he is still suffering with the dermatitis. They can be performed after the eruption has disappeared but they may then yield negative results even though the fur has been the cause of the dermatitis because an immunity may have developed after recovery. When performing patch tests after the eruption has disappeared the patches should be applied to the site of the eruption to obtain the best results.

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CHAPTER XXVI

DERMATOSES FROM GLASS MANUFACTURE

The principal chemicals used in the manufacture of glass are silica (in the form of sand), pearl ash, soda ash and lime. The following is a complete list of the chemicals used in the factories where this study was made:

Alumina
Aluminum sulphate
Ammonium chloride
Antimony oxide
Antimony sulphide
Arsenic

Barium chloride
Barium sulphate
Barium carbonate
Beryllium carbonate
Bismuth carbonate
Bone ash
Borax
Boric acid

Cadmium acetate
Cadmium carbonate
Cadmium hydrate
Cadmium sulphide
Calcium carbonate
Calcium fluoride
Ceric nitrate
Cerium nitrate
Cerium oxide
Chrome oxide
Coal
Cobalt oxide
Copper oxide
Clay
Cryolite

Dicalcium phosphate
Didymium-lanthanum hydrates
Didymium oxide

Feldspar
Ferrous oxalate
Fluorspar

Gold

Hydrochloric acid

Iron chloride
Iron oxide

Kaolin

Lead carbonate
Lead silicate
Lepidolite
Lime
Litharge
Lithium carbonate

Magnesia
Magnesite
Manganese carbonate
Manganese dioxide
Molybdic oxide

Nickel oxide

Pearl ash
Phosphoric acid
Potassium bromide
Potassium chloride
Potassium dichromate
Potassium fluoride
Potassium iodide
Potassium nitrate

Red lead
Rutile

Salt
Saltpetre
Sand
Selenium
Silver chloride
Silver nitrate
Silver oxide
Soda
Sodium dichromate
Sodium fluoride
Sodium phosphate
Sodium peroxide
Sodium sulphate
Spodumene
Sugar
Sulphur
Starch

Tartaric acid
Tin oxide
Tellurium oxide
Titanium dioxide
Thorium oxide
Tungstic oxide

Uranium

Vanadic acid

Zinc dust
Zinc oxide
Zinc silicate
Zircon
Zirconium oxide

These chemicals are used to give various properties to the glass. The boric acid and the borates impart heat resistance and diminish heat expansion arsenic is used as a decolorizer lead to make glass soft for cutting and most of the metallic oxides are used to impart particular colors to the glass.

The chemicals are brought to the glass factories usually in freight cars from which they are unloaded and placed into storage bin. In the unloading operation the workers are exposed to the dust of the chemicals and the clothes are usually saturated with it. In one large plant where sheet glass is manufactured there occurred during the course of one year among 40 men employed in unloading the chemicals 17 cases of dermatitis of sufficient severity to lose time from work. Most of the cases occurred in the hot months of the year and the site of the lesion was usually at points of friction with the clothes such as the wrist the collar line and the ankles. The chief irritants were the soda ash lime and arsenic

In hot weather the perspiration coming in contact with the alkali forms hydroxide and this attacks the skin causing dermatitis in some cases and actual ulceration in others

The men working in the storage bins, where these materials are stored are required to enter the bins for the purpose of shoveling the chemicals In doing this they are exposed to the action of the chemical just as are the unloaders

The men working at weighing and mixing are also exposed to the action of these chemicals. The mixed materials are often dumped on traveling belts which carry them into a hopper leading into the furnace and the men attending to the proper operation of these belts are also exposed to the dust of the chemicals. Men working at operations which expose them to the dust of soda ash arsenic and lime may not only develop dermatitis but they often have a nasal mucitis resulting in ulceration and perforation of the nasal septum—this despite the fact that they are supplied with respirators

In the manufacture of machine-made bottles by the Owens or other bottle-making machines, the molten glass is automatically sucked up and blown in the molds and discharged from them without ever being touched by hand hence there are no particular skin hazards in this kind of work The same is true in making window glass where the molten glass is pulled up from the furnace and over a roller in the form of a continuous sheet and cooled by passing over a long platform at the end of which it is cut off into pieces of the desired size

In making plate glass the batch of mixed chemicals is placed into special fireproof pots which hold a sufficient amount of material for the making of one plate of glass. The pots are heated in furnaces where they are kept until the contents are melted and combined into molten glass. They are then lifted out of the furnace by cranes and the contents emptied into a machine which has a narrow slit between two rollers through which the glass flows out in the form

of a plate onto a movable table of suitable size The table is provided with wheels and after the glass flows onto it it is slowly passed through a long enclosed tunnel in which the glass is allowed to gradually cool. It comes out at the other end as a dull rough surfaced plate of glass. The plate is then transferred to another table and embedded in lime in order to keep it from slipping while undergoing the polishing process The workers embedding the plate glass for polishing sometimes suffer with dermatitis from contact with the lime. The dermatitis may manifest itself as an acute erythematous vesicular rash on the hands and the forearms or in some cases as a chronic fissured eczema.

The polishing of the glass is done mechanically by a long series of polishers consisting of revolving pads saturated with a red paste called rouge which consists mainly of iron oxide (Fe_2O_3) After one side of the plate is polished it is turned over and the other side is put through the same process

Safety glass for automobiles is manufactured by gluing two panes of glass to a thin sheet of cellulose acetate or other plastic inserted between them This is then passed through a series of rolls under pressure. Throughout this process the glass is sprayed with diethylene glycol. When the glass comes out of the press machine it is wet with diethylene glycol and the men working at the end of the press machine place the glass into perforated tubs and when the tubs are filled they are placed in an autoclave containing hot petroleum oil in order to "cure them or to complete the cementing process.

In a factory where safety glass is manufactured there was an outbreak of dermatitis limited to workers who were employed in placing the glass into the autoclave and removing it from there. Among 23 men employed in this operation 12 suffered from dermatitis The dermatitis affected the forearms, the thighs and the legs and was especially severe among those who had an excess of hair on the extremities The dermatitis took the form of a folliculitis with small pustules involving the hair follicles. (Fig 47) It was first thought that the diethylene glycol was the cause of the dermatitis but patch tests with it were negative whereas positive results were obtained on some of the workers from patch tests with the oil used in the autoclave The oil consisted of a light straw colored petroleum oil contaminated with a small amount of diethylene glycol and with adhesive material used to make the glass adhere to the cellulose acetate The clothes of the workers in this operation were saturated with oil and were not frequently changed

After the glass comes out of the autoclave it is placed in a washing machine where the oil is washed off with a solution of soda ash The workers on this washing machine were not affected with dermatitis None of the workers engaged in the operations where safety glass is further processed were affected.

These fact together with the character of the lesions lead to the conclusion that the folliculitis was due to the oil soaked work clothes.

Providing the men with long oilproof aprons and with clean coveralls changed daily, the installation of a double set of locker rooms—one for street clothes and the other for soiled work clothes and supervised compulsory shower baths for the men after work controlled the outbreak and prevented further recurrence of dermatitis.

FIG. 47. Safety glass worker. Oil folliculitis due to oil-soaked clothing.

HAND BLOWN GLASS MANUFACTURE

In the manufacture of hand blown glass a "gatherer" dips a long iron tool which is a combination blow pipe and gathering iron into the furnace and coils on the end of it a sufficient amount of molten glass. He then blows a bubble of air through it and passes the pipe and the glass to the "glass blower." The blower then proceeds to blow more air into the molten glass and places it into an iron mold. He continues to blow until the glass fills the mold. He then breaks off the glass remaining on the pipe from the part which is in the mold. After cooling for a little while the mold is opened and the formed glass is taken out.

Some fine pieces of art glass are not blown in molds but are hand shaped on the gathering iron by turning the iron and shaping the molten glass with an iron tool.

Dermatitis and other skin lesions have been reported as occurring among glass blowers. Epstein reports warts, wheals and cancer of the hands of glass blowers from manipulation of the blow pipes. Kavelerow and Kogan describe dryness, roughness, erythema and edema of the hands and changes in the nails of glass pourers. Koelsch describes changes in the incisor teeth and the mucous membranes of glass blowers. Richert also describes erosions of the incisor teeth and ulceration of the lips in glass blowers.

R. Prosser White calls attention to calloused horny skin on the palms of both hands in glass blowers and attributes it first to the heavy hot iron blow pipe which is held in the left hand and secondly to the stock grease made up of charcoal pitch and rosin which he states the blower smears on his hands and on the molds.

Glass blowers cataract has been described by J. Badot who reports that among a series of 200 cases of cataract occurring among glass blowers, he found 5 per cent occurring below the age of forty years 42 per cent from the ages of forty to sixty years and 53 per cent occurring in the age group from sixty to eighty years. Glass blowers cataract has been variously ascribed to the action of the intense heat and light to the excessive sweating and to the ultra violet and infra red radiations, to which glass blowers are exposed

Fig. 48.—Glass blower hands. Callouses from blow pipe and deep seated blisters under callouses.

In the inspection of a large factory where hand blown glass is made it was noted that the gatherers had both their hands heavily calloused from the gathering iron. The blowers hands were also calloused but not so much as those of the gatherers. There was no grease used on the gathering iron or the blow pipe in this factory as described by R. Prosser White. The callouses in themselves are not painful but often the heat of the iron will cause blisters to form underneath the callouses. (Fig. 48.) The blisters are usually painful and can only be cured by removing the callouses and opening the blisters. This usually necessitates the laying off of the worker from work for a number of days.

The glass blowers were found to have the teeth discolored and the incisor teeth were eroded and sometimes broken presumably from contact with the iron blow pipe. (Fig. 49.) The discoloration on the teeth was superficial and could easily be cleaned off. There were no lesions found on the lips the tongue or the mouth of any

of the blowers but leukoplakia on the mucous membranes of the cheeks were noted in a large percentage of them. In this factory the gatherers and the blowers work in pairs and as they blow through the same gathering iron they realize that they are apt to convey to each other any buccal or respiratory infections. Hence they keep close watch for these conditions and will not work with anyone having a cold or sores on the lips and mouth.

A full time dentist is also employed in this factory for periodic inspection, treatment and repair of dental lesions.

Fig. 49.—Glass blower, teeth eroded edge.

Glass tubing is made by machine and by hand. When made by machine the molten glass from the furnace is directly extruded over a mandrel and pulled into a continuous tube of desired diameter, cooled and cut into suitable lengths.

In making hand-made tubing glass is taken from the furnace on a gathering iron and while the blower blows it another worker grabs an end with an iron tool and pulls it to the desired length and diameter. This requires expert work and only glass tubing of special diameter is made in this manner.

The men working at the furnaces where ordinary lime glass is melted do not wear dark glasses but look through a metal screen into the furnace. The metal screen is said to have the effect of shutting off much of the heat and the light from the eyes. The gatherers and blowers who work with hard glass, such as Pyrex, where a much higher degree of heat is required to melt the glass, wear dark glasses to shut out the harmful rays from the eyes. There were no cases of cataract found among the workers in this factory.

Workers smoothing and grinding ordinary glass use emery wheels and water for this purpose. No cases of dermatitis were seen among these workers but dermatitis—the so-called "water itch"—does occur among the grinders of optical lenses where, instead of water, various mixtures of turpentine, oil and kerosene are used.

In etching glass the piece is first coated with paraffin by dipping it in a bath of molten paraffin. The design to be etched is then drawn into the paraffin by means of a pantograph. The glass is then dipped in a solution of hydrofluoric acid which attacks the exposed glass of the design and kept there until etched to a sufficient degree. It is then taken out, washed with water, and the paraffin removed. Etchers wear rubber gloves, but occasionally receive burns from splashes of hydrofluoric acid and through holes in defective gloves. These burns are peculiar in that the worker does

not know that he has been burned until a few hours later when the burnt area commences to smart. Hydrofluoric acid burns sometimes develop into deep ulcers covered by an adherent tenacious crust which will not heal unless the crust is removed and the base of the ulcer curetted with a sharp curette.

Crystal glass, so-called, consists principally of lead silicate. On it is hand engraved various designs and pictures. In grinding the designs the workers use a small revolving wheel consisting of carborundum and emery. Water is used as a lubricant. After the design is completed, the glass is polished by dipping in a mixture of sulphuric and hydrofluoric acids. In a factory employing 50 men engaged in grinding and engraving glass, there were no cases of dermatitis found.

PREVENTIVE MEASURES FOR DERMATITIS IN GLASS WORKERS

The unloading of chemicals from freight cars should be done in such a manner as to require the minimum of manual labor and the minimum generation of dust. Workers should not be required to enter the cars and shovel the chemicals. Railroad cars containing the chemicals used in glass manufacture can be so constructed that the contents can be discharged from openings in the sloping floor of the car. The floor of the car should be fitted with doors opening out towards the tracks and fitting into the openings of storage bins located underneath the rails. Men working as batch mixers and weighers should be provided with a daily change of clean work clothes. There should be a double set of locker rooms for these men—one set for street clothes and the other set of locker rooms for holding clean work clothes and for discarding dirty work clothes. There should be supervised compulsory shower baths for these men after work. The batches of mixed chemicals should be moistened so as to prevent dust. Respirators should be provided and wearing them should be made compulsory and the filters in the respirators should be cleaned daily.

In a glass factory where all these precautions were taken, dermatitis from chemicals was practically eliminated.

Nasal mucitis is much more difficult to prevent. It seems that the ordinary respirator does not keep out the irritant chemicals, or that the men do not always wear the respirators. Therefore in addition to respirators the men should be required to insert petroleum jelly in the nostrils when they begin their work. This acts as a protective coating to the mucous membrane. The petroleum jelly can be wiped out of the nostrils at the end of the day's work while the men are taking their shower baths.

Workers embedding plate glass on tables before polishing, should wear leather gauntlets to protect them from the lime.

Gatherers and blowers of hand-made glass should be provided with individual wooden or rubber mouth pieces which fit into blow

pipes, in order to eliminate the possibility of carrying infections and also to lessen trauma to the teeth and buccal mucous membranes from the iron of the blow pipes.

Glass factories should be equipped with adequate first aid rooms having a competent physician or registered nurse in charge.

In factories where hand blown glass is made there should be periodic examinations of the teeth and mouth.

Dark glasses should be worn by those workers who are required to look at the molten glass in order to prevent glass blower's cataract.

Glass Wool and Thread.—Rock wool and asbestos have been used as insulating materials for many years and the skin hazards involved in their manufacture and use are well known although few cases of dermatitis resulting from the handling of these materials have been reported. Fiber glass is a relatively new type of commercial insulating material* concerning which as a cause of dermatitis there is little information available. However from one source the following is obtained. Of more than 4,000 case record submitted during the past year by state compensation boards to the Office of Dermatoses Investigations of the Division of Industrial Hygiene, National Institute of Health, it was found that only 10 cases of dermatitis were attributed to the handling of insulating materials and that 8 of these were attributed specifically to glass insulating materials.

An investigation of the skin hazards in the manufacture of glass wool and glass textiles, requested by a group of workers handling these products, was undertaken with the purpose of studying the processes involved and making recommendations looking toward the elimination of the hazards.

One plant engaged in the manufacture of glass wool for insulation and glass thread for the manufacture of textiles was inspected. Medical records of this factory, which employs 2,000 workers, show that among the workers reporting to the dispensary for treatment during a six-month period there were 25 cases diagnosed as industrial dermatitis.

Inspection of the workers revealed other cases of dermatitis among those who had not reported to the dispensary for treatment.

Industrial Process.—The basic chemicals are shipped to the plant in freight cars. Workers transfer the chemicals from the freight cars to mechanical conveyors which carry the materials to weighing chambers. The materials are automatically weighed, thoroughly mixed, and carried to the melting furnaces or tanks.

The interior of the freight cars, the floors, windows, walls, and machinery in the batch houses are covered by dusts of the basic chemicals. Employees in this section are exposed to the dusts of these chemicals, some of which are skin irritants. Some develop

* The ingredients used in the manufacture of fiber glass are those commonly employed in making high-grade glass, primarily silica sand, lime, soda ash and borax.

pruritic erythema of the flexural regions and exposed parts during the warm months of the year. Others notice nosebleed on occasion probably due to sodium carbonate dust or other alkalis which irritate the nasal mucosa.

Workers who experience irritations or wish to guard against them should wear clean work clothes daily and should take shower baths after work. They should be provided with individual pairs of rubber boots and leather gloves. Work shirts should be high-necked and heavy. They should wear impervious sleeves and aprons over their work clothes. The men are required to wear respirators and when they are worn an "invisible glove" type of cream should be applied to the face at the points of contact to protect it from irritation. The nasal septum should be protected by inserting petroleum jelly into the nostrils two or three times daily. Frequent cleaning and washing of the floors, windows, walls and machinery will eliminate much of the dust.

In the furnaces the batches are converted into molten glass. Small inspection holes are open and the glare is quite marked. In routine inspection of the process portable colored glass filters are used to avoid conjunctivitis, eyestrain and glass-blowers' cataract. Since the workers often neglect using the hand filters, the inspection holes should be covered by colored filters.

Glass wool for air filtration and thermal and sound insulation is manufactured similarly but the binders and lubricants differ for the specified products.

The molten glass falls in fine streams through apertures in the forehearths of the furnaces. The molten glass is yanked into fibers by high pressure steam and the fibers drop onto a conveyor belt to form a layer of "wool." The formed wool layer is sprayed with the binder or lubricant; when binders are used the "wool" passes through an oven in which the binder is cured. The binder serves to hold the fine fibers together at the desired density. When a phenol formaldehyde resin binder is used it is diluted with a pine product solvent. A lubricant is used on plain fibers to prevent breakage and to make the product more water repellent. It consists of a mixture of petroleum oil and stearic acid. Because the phenol formaldehyde resins are spread in thin films over large surface areas on the glass wool filaments they are completely cured in the curing and drying ovens.

The odor of formaldehyde could be detected in the area where the uncured resin binder is sprayed on the glass wool but not on the wool as it emerged from the curing ovens. If men working in the area where the uncured resin binder is sprayed on the wool develop dermatitis they should wear impervious clothing and use a mixture of lanolin and castor oil as a protective ointment against the irritant formaldehyde fumes. To date no cases of dermatitis have been reported in this department.

The binder used in glass wool for air filtration is a rubber compound and is apparently not irritating, as the men working in this

pipes in order to eliminate the possibility of carrying infections and also to lessen trauma to the teeth and buccal mucous membranes from the iron of the blow pipes

Glass factories should be equipped with adequate first aid rooms having a competent physician or registered nurse in charge

In factories where hand blown glass is made there should be periodic examinations of the teeth and mouth

Dark glasses should be worn by those workers who are required to look at the molten glass in order to prevent glass blower's cataract.

Glass Wool and Thread.—Rock wool and asbestos have been used as insulating materials for many years and the skin hazards involved in their manufacture and use are well known although few cases of dermatitis resulting from the handling of these materials have been reported Fiber glass is a relatively new type of commercial insulating material* concerning which as a cause of dermatitis there is little information available However from one source the following is obtained Of more than 4 000 case records submitted during the past year by state compensation boards to the Office of Dermatoses Investigations of the Division of Industrial Hygiene National Institute of Health it was found that only 16 cases of dermatitis were attributed to the handling of insulating materials and that 5 of these were attributed specifically to glass insulating materials

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around the ovens. No dermatitis was found in this department Recommendations as discussed above apply here

Manufacture of Glass Thread.—The special chemical mixtures required for glass textiles are melted and the glass is formed into small uniform marbles to facilitate inspection for improper mixing and dirt particles. Imperfections and particles of dirt in the glass if allowed to remain produce defects in the glass fibers. The employees in the glass melting and marble forming section wear coveralls, safety shoes colored face and eye shields and asbestos-covered gloves for protection against the furnace heat and glare and the hot glass marbles. After inspection the marbles are reheated in other sections of the plant and the molten glass passed through small apertures in the bottom of the furnaces from which it is drawn into fibers.

When fibers are in the form of continuous filaments a specified number of them slope down and are coated with a layer of liquid binder (consisting of a mixture of starch, polyvinyl alcohol and a substituted pyrazine) and are wound on drums. The filaments must be broken when the drums are changed The hands of the workmen in this section are exposed to the liquid binder

Of 65 men in this section 12 reported for treatment of dermatitis during the last six months. But prior to a recent change in the binder they noted redness itching and acute eczematization of the hands and wrists and some noted spread of the eruption to other parts of the body The eruption appeared from two to eight weeks after first contact with the binder On questioning it was learned that almost all the men developed a skin eruption at one time or another but many of them did not report for treatment. Several of the employees noted that the eruption subsided within a few weeks despite continued contact with the binder Dermatitis was more frequent during the warm months

Seven employees with dermatitis were patch tested with the binder At the end of twenty-four hours three of these men had positive reactions Two control subjects never previously exposed to the binder had negative reactions at the end of twenty-four hours.

The history of onset after several weeks of exposure and the results of the patch tests indicate that the binder is a sensitizing agent rather than a primary irritant The fact that some of the sensitized employees recovered from dermatitis while they were working shows that immunity may develop in sensitized workers if they continue to work, despite their dermatitis.

The employees in this section should wear impervious sleeves and aprons, high-necked shirts and thin rubber gloves with the sleeves fastened over the gloves at the wrists. The men should wear clean work clothes daily and should take shower baths after work An "invisible glove" type of ointment which is impervious to the binder should be used by the men who cannot or will not work with gloves or protective clothing The preparation should contain a material that will adhere to the surface of the skin and protect it

from contact with the binder. The ointment should be applied to the exposed surfaces of the body two or three times daily. New workers who become hypersensitive to the binder but who develop only mild reactions should be allowed to work for a period of three weeks in the hope that they will develop immunity or become hardened. If this does not occur, they should be removed from the job.

In retainer mat manufacture the glass fibers are formed by a jet of steam and are blown onto a metal conveyor belt. The layer of glass filaments is sprayed with a starch binder and passes through an oven in which the binder dries. The paper-like sheet of fibers is gathered in large rolls, which may be cut to specified lengths, and the rolls are loaded by hand onto carts. Since this process rarely produces slugs, there is no evident need of protective clothing.

In the formation of "stable fibers" for textile use, glass marbles are melted, drawn by steam or air, sprayed with a mineral oil binder and then passed through a gas flame before they are gathered on a revolving grooved metal drum. The fibers are drawn off the drum through a narrow mouthed metal tube to form a sliver. This sliver is wound onto spools. The men working in this section are exposed to the vapors of the oil binder and the open gas flame. The binder appears to be non-irritating, since no dermatitis has been found in this department.

Glass textile manufacture is carried out in a manner identical with other textile industries.

The employees in the spinning, spooling, and weaving sections sometimes develop itching and redness of the neck and forearms due to exposure to the "fly," the fine filaments of glass which come off the thread as it is manipulated. Employees who experience annoyance should wear impervious sleeves and aprons.

The girls working at the tape machines have noted irritation of the nose and throat in addition to the itching and redness of the arms, neck, and face. Several of the older employees volunteered the information that the skin eruption and the irritation of the nose and throat have been more marked since the use of the recently abandoned mixture of starch, polyvinyl alcohol, and the substituted pyrazine as the binder in the continuous filament yarns. These employees should wear impervious sleeves and aprons, and they should insert petroleum jelly into their nostrils once or twice daily.

In the bonded mat section the girls cut large mats into the required sizes, dip the edges of the mats in a binder mixture to prevent fraying, and pack them for shipment. Some of these girls complain of itching of their arms and necks due to the "fly." They wear improvised aprons and use talcum powder as a protective on their necks and arms. These girls should wear impervious sleeves and aprons as well as the rubber gloves they now wear, and should use an "invisible glove" type of ointment instead of talcum powder.

The hazards to workmen using glass wool products for insulation and for other purposes are those due to abrasions by slugs in the

glass wool. A few may develop allergic dermatitis from contact with improperly cured binders. If such workers wear leather gloves impervious sleeves and aprons they will be afforded adequate protection against these hazards.

Workers handling glass fiber in textile manufacturing may develop dermatitis from the mechanical cutting action of the fibers on the skin (Fig 50) and a small percentage of them may develop an allergic dermatitis from the binder Irritation of the arms, neck chest and other parts of the body may be prevented by wearing impervious sleeves and aprons Irritation of the nasal mucosa may be prevented by inserting a bland grease into the nostrils two or three times a day

FIG. 50.—Dermatitis from glass wool.

According to an official of the company the incidence of dermatitis in this plant was low being in the order of 1 per cent of the workers employed No compensation cases have developed indicating that the dermatitis is not severe Some new employees experience sensitivity to handling the glass fibers for a few days and may wear gloves or protective clothing at first but an immunity seems to develop quickly so that the great majority of experienced workers prefer to work without gloves or special clothing Exceptions are found among employees handling hot equipment coarse filter fibers, metal lath and other collateral materials of like nature In the principal wool and textile departments, workers, according to management experience report greater discomfort from gloves and protective clothing than from the material with which they work.

Good practice requires that all workers be advised to follow the protective and preventive measures indicated in this report, according to the nature of their work. Those who prove sensitive to any of the binders, lubricants or other materials they handle, should be required to follow the indicated protective measures

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CHAPTER XXVII

DERMATOSES CAUSED BY INSECTICIDES AND FUNGICIDES

THE majority of insecticides and fungicides are poisonous and are skin irritants. Contact dermatitis occurs among those who manufacture and use these substances.

Pyrethrum.—Pyrethrum which is widely used is an ingredient of many fly, mosquito, ant, and cockroach sprays and powders as well as of agricultural insecticides and cattle sprays. It is obtained from the *Chrysanthemum pyrethrum* and from *Pyrethrum cinerariifolium* flowers which resemble the ordinary daisy and grow in various parts of Europe, Asia, Australia and America. They are cultivated for use as insecticides.

The flower from which the insecticide is obtained should not be confused with the pyrethrum of the pharmacopoeia. This is obtained from the root of the *Anacyclus pyrethrum*, a plant which grows in Northern Africa and Arabia, and is used as a sialogogue and analgesic.

According to Dudley Grant of the Standard Oil Company of New Jersey, the active insecticidal principles of pyrethrum are two non-volatile substances called *pyrethrin I* and *pyrethrin II*, and are esters of pyrethrolone and chrysanthemum acids. According to J. Fujitani * the active insecticidal principle is a neutral ester called pyrethrone, while E. Reeb states † it is a substance called pyrethrotoxic acid. C. C. McDonnell ‡ found both of these substances present in the pyrethrum plant and both insecticidal.

Pyrethrum powder obstructs the trachea of insects and mechanically suffocates them. When absorbed either in the form of a spray or as a powder, it paralyzes the neuro-muscular system of insects. It has also been found to be toxic for rabbits and dogs hypodermically and intravenously, producing convulsions and paralysis.

When pyrethrum is used as a spray, it is usually dissolved in a petroleum distillate to which may be added oil of citronella, pine oil, cedar wood oil or sometimes such poisons as para dichlorbenzole to give an agreeable odor. When used as an insect powder, it may be mixed with borax, sodium fluoride, naphthalene, arsenic compounds, thallium sulphate, etc.

McCord reported 18 cases of dermatitis during the summer months among 85 workers in a plant which manufactured an insecticide containing pyrethrum.

The authors investigated a chemical plant which manufactured an insecticidal spray containing pyrethrum in a petroleum distillate.

* Chemistry and Pharmacy of Insect Powders, Chemical Abstracts, 5, 1966, 1911.

† Principes Actifs de la Poudre Insecticides, Jour. Pharm., Elsass-Lothringen, 38, 247, December, 1900.

‡ United States Department of Agriculture, Insect Bulletin No. 824, p. 72.

There were 20 cases of dermatitis among 100 workers due to sensitivity to pyrethrum obtained from the Japanese daisy. Some of these cases were so sensitive that they had to stop working even after the process of manufacture was changed so as to be totally enclosed.

Dermatitis has been reported among the users of insecticides containing pyrethrum. Sulzberger and Weinberg report dermatitis from "Black Flag," an insect powder containing pyrethrum. Kesten and Laszlow also report dermatitis from pyrethrum.

Other cases have been reported as noted in the appended bibliography.

Arsenic.—Arsenic is an ingredient of a great many insecticides and fungicides and is one of the principal ingredients of agricultural sprays and powders. Arsenic is found in Nature in the free state but more frequently in the form of sulphides such as realgar (As_2S_2), orpiment (As_2S_3), arsenical pyrites (FeSAs), and smalt or mispickel (CoSAs). Arsenic is commonly manufactured by heating arsenical pyrites in the absence of air. The arsenic sublimes and iron sulphide remains. Arsenic acid (H_3AsO_4) is made by the action of strong nitric acid on arsenic trioxide.

The principal arsenicals used in insecticides are calcium arsenate, arsenic trioxide, manganese arsenate, and Paris or Schweinfurt green, a double arsenite plus copper acetate ($3Cu(AsO_2)_2 + Cu(C_2H_3O_2)_2$).

Many observers have reported that exposure to arsenic causes dermatitis, melanosis, epidermal hyperplasia, particularly in the form of keratoses of the palms and soles, although they may occur elsewhere on the body. The keratoses may in rare instances undergo malignant changes.

Vesicular or vesico-bullous dermatitis with crusting, localized especially on the lower part of the abdomen, groins and the thighs have been reported. Ulceration of the skin and of the nasal septum have also been reported among many arsenic workers.

Workers loading arsenic or its compounds into railroad cars, bags or barrels, sometimes suffer with generalized dermatitis, melanosis or hyperkeratosis, similar to that seen following the ingestion of arsenic. Those engaged in mining and smelting arsenic ores may also be similarly affected. In such cases a patch test with a 5 per cent solution of sodium arsenite usually gives a positive reaction and arsenic can be found in the hair and nails.

In our studies in a chemical plant making arsenical insecticides and employing about 65 workers, we noted 4 cases of dermatitis of the hands and forearms. There were erythematous, papular, vesicular, and scaly lesions. Patch tests performed with white arsenic, lead arsenate, and calcium arsenate in pure form showed a positive reaction after twenty-four hours only to calcium arsenate. (Fig. 51.) The calcium arsenate contained from 10 to 12 per cent of lime as an impurity from its manufacture, and it was likely that the dermatitis and patch test reaction may have been due to the lime.

P. Vigne in an article entitled "Occupational Dermatitis from Arsenic,"* states that patch tests on the dry skin with dry arsenic powder produces no effect but that in the presence of moisture such as sweat a dermatitis results.

FIG. 51.—Dermatitis due to calcium arsenate. Fungicide maker.

In the plant examined by the authors, the following safety measures were used to protect the workers against arsenic.

Arsenic trioxide was unloaded from tank cars by suction through a vacuum pump, the chemical being blown directly into the storage tanks. Before this system of loading and storing was instituted, dermatitis due to arsenic trioxide was fairly common. This has since become rare. In this plant, wherever arsenic in the dry state was processed, it was done so in totally enclosed apparatus. The wet calcium arsenate and lead arsenate were dried in an enclosed continuous drum drier which discharged its contents through a pipe into a totally enclosed grinding mill. The men who worked around this apparatus wore respirators and protective clothing including gloves. In the packaging room where the powdered arsenates were weighed and placed in paper bags, a special ventilating system eliminated dust and there were suction vents over each operation. The men in this room had to wear gloves and long sleeves and were supplied with clean coveralls twice a week. Their respirators were cleaned daily and they were compelled to take shower baths and completely change their clothes at the end of the work day. Despite these precautions, dermatitis occasionally occurred. The groins, armpits, and hands were mostly affected and sometimes the face became inflamed at the site of contact with the respirator.

Dermatitis from arsenic occurs among the handlers and users of arsenicals. Ayres and Anderson report cases of arsenic poisoning resulting from eating vegetables sprayed with arsenic and also men-

* Arch. Dermat. and Syph., 23, 721, April 1931.

tion a case of arsenic dermatitis in an employee of a termite exterminating company Myers and Throne describe cases of dermatitis due to the retention of arsenic in the system As a result of this many states have passed stringent laws for the removal of insecticide sprays from fruits and vegetables before they are shipped to market

Gross and Nelson state that arsenic is evolved during the smoking of cigars cigarettes and pipe tobacco and report a case of dermatitis due to arsenic in the tobacco of certain brands of cigarettes.

The arsenical insecticides are used not only as sprays for fruit and vegetables but also to combat locusts, treat mange among domestic animals and kill cockroaches and bed bugs

Irvine and Turnacliff have reported dermatitis among the users of insect powders containing arsenic and Leoncini has reported dermatitis among men employed in spreading arsenic for the destruction of grasshoppers

The arsenical insecticides are also used for the destruction of mosquitos by spreading over swampy areas G diMattei reports dermatitis caused by Paris green among workers employed in this manner

Arsenic pigments were used for coloring wall paper candles and even toys Cases of poisoning have been reported from arsenic pigments in wall paper The pigment decomposed into hydrogen arsenide or arsine (AsH_3) a deadly poison The use of arsenic for these purposes has since been prohibited

Arsenic compounds are used in the preparation of hides to treat felt for hats as mordants in calico printing in the manufacture of glass and to destroy rats Damage to the skin may result among workers engaged in any of these occupations

Fluorides.—Sodium fluoride is extensively used in cockroach powders moth killers and ant poisons. It is also used in fluxes for soldering and welding stainless steel and aluminum alloys. Dilute solutions are used in laundries to remove rust spots from fabrics It can be made by the action of hydrofluoric acid on soda ash. In a factory where this process is used 5 out of 8 workers at this operation have had ulceration and perforation of the nasal septum Irritation of the nasal mucous membranes from sodium fluoride manifests itself within a week or two after starting work by itching and burning inside the nose It is due to the inhalation of the dust which has a corrosive action on the mucous membrane

Burns of the hands and fingers with hydrofluoric acid and sodium fluoride sometimes occur among the workers. When hydrofluoric acid accidentally gets on the skin it causes a burn which is not felt until twelve to twenty-four hours later A deep ulcer with a thick adherent slough usually forms heals with difficulty and leaves a deep scar If hydrofluoric acid gets under the nails the nail bed suppurates and the nail is shed Healing and regrowth of the new nail take a long time

Flushing with water is the best immediate treatment when

fluorides touch the skin. The treatment for fluoride burns is thorough curettage of the base of the ulcer to remove all traces of fluoride and to treat the resulting wound aseptically Injections of calcium gluconate under the burned skin is advised by some but has not given good results in the experience of the authors.

Sodium silicofluoride is used in agricultural sprays although its use on fruits and vegetables is prohibited in many states because of the danger of poisoning to consumers In a concentration of as little as 1 part per 1,000 000 in drinking water fluorides have caused mottling of the enamel of the teeth among children Among adults as little as 5 parts per 1,000 000 of fluorine has led to a marked degree of mottled enamel.

Barium fluoro silicate is also used as an agricultural insecticide its action on the skin is not as severe as that of sodium fluoride The compounds of fluorine used as agricultural sprays are poisonous to consumers but according to Marcovitch they are less poisonous than arsenic The silico fluorides and the fluoro silicates are also used on fabrics as moth repellents.

Anhydrous hydrofluoric acid is used in making high octane gasoline and severe burns occasionally are caused by it.

Workers engaged in the manufacture of fluorides should be protected against dust and fumes by suction hoods over open processes, thorough cleanliness of rooms, and removal of dust by wet cleaning and by protective clothing such as rubber gloves aprons boots, and respirators.

Dermatitis and burns may occur among the users of insect powders containing fluorides. Poisoning may also occur from the accidental ingestion of such powders. They should be and usually are colored with a blue dye to prevent being mistaken for epsom salts bicarbonate of soda etc.

Copper Cyanide.—Copper cyanide is sometimes an ingredient of insecticides and fungicides. It is made by the action of copper chloride on sodium cyanide The process of manufacture is totally enclosed but the workers who grind the substance to a powder and load it into barrels are exposed to the dust and often suffer from ulceration and perforation of the nasal septum

Copper sulphate is also used in agricultural insecticidal sprays and copper oxide is used to treat the hulls of ships for the purpose of repelling marine parasites Dermatitis may occur from handling either of these compound

Derris Root derived from *Derris elliptica* a plant cultivated in Borneo and its active principle Rotenone are extensively used as agricultural sprays According to Haag there is little danger to human beings from eating fruits sprayed with rotenone although workers exposed to the Derris dust should wear masks since it produces fatty degeneration of the liver and other organs if inhaled in sufficient quantity

Nicotine —Nicotine is an oily colorless liquid ($C_{10}H_{14}N_2$) It is made from tobacco in which it is present in 0.5 to 9 per cent strength.

It is extensively used as an agricultural spray. Solutions of nicotine are also used as sheep dips to destroy the green and white fly. They are sold for insecticidal sprays as a 40 or 95 per cent solution of nicotine sulphate.

Lockhart reported a case of nicotine poisoning in a girl employed in making insecticides. She accidentally spilled 2 drachms of a 95 per cent solution of nicotine on her coverall sleeve and although she immediately changed the garment, washed her arm with hot water and dried herself before going on with her work, she collapsed twenty minutes later, pallid, cold and pulseless. The patient slowly recovered and nicotine was found in the vomit. Lockhart concluded that nicotine was a powerful poison when applied to the skin and should be removed by washing with cold water.

Faulkner reported a case of nicotine poisoning by absorption through the skin from an insecticide containing 40 per cent nicotine. Fretwurst and Herts reported a case of poisoning from a solution containing 20 per cent nicotine used as an insecticidal spray.

Cubé.—Cubé, Cuvi, Cumé, Barbasco, Haiari, Neko, Timbo and Stinkwood are names applied to several plants used as fish poisons in tropical American countries. They belong to the family Fabaceae or Leguminosae or Papilionaceae and the genus Lonchocarpus. The species Jacquinia and some plants of the family Sapindaceae are also called by these names. A few plants belonging to the genus Lonchocarpus are also found in Australia and Africa.

Among the identified species of Lonchocarpus the *L. nicou* is the richest in insecticidal principles. It is a climbing shrub or Liana and may attain a height of 12 feet. It has alternate leaves about 12 inches long and has 7 to 9 leaflets 4 to 5 inches long. The lower surface of the leaf is covered with light brown hairs. The active principles are concentrated in the milky pungent juice obtained from the root and stem. The leaves of the plant have a purgative action. The sap is diluted and used as a cattle wash to kill ticks. The powdered stems when dusted on cats and dogs will kill or drive off parasites. A hot water extract of the stems and root will do the same. The milky pungent root juice when placed into still waters will cause the fish to rise to the surface with the gills wide open gasping for air. The natives then catch them. The chief active ingredients are Rotenone ($C_{23}H_{22}O_6$), Deguelin and Tephrosine, but there are other unrecognized toxic ingredients.

While the dried roots are exported from Peru, exportation of the plant for cultivation is prohibited. Cubé and rotenone are sensitizers and dermatitis has been reported among workers making and using insecticidal sprays containing it.

The natives use the juice from the leaves as a remedy for snake bites and the smoke from burning roots as a treatment for colds. The oil expressed from the leaves is used as an anthelmintic. Rotenone is also used to destroy lice and their eggs and for the treatment of mange. The root of *Derris elliptica* is also a source of Rotenone and has the same allergic properties as Cubé.

Methyl bromide (CH_3Br) is a colorless volatile liquid boiling at 4.5° C. It is used as a delousing agent for clothes. Exposure to it causes vesicular dermatitis. If seen early a small area of localized erythema is noted from this large bullous lesions develop. Placing the part in cold water for thirty minutes and applying wet dressings may prevent the development of bullae. If vesicles have developed they should be opened and covered with wet dressing.

Hydrocyanic Acid.—Hydrocyanic acid is used as a fumigant to destroy rodents and insects on ships and in houses. It is also used to fumigate trees. For this purpose a tent is spread over the tree and the gas introduced. Cases of systemic poisoning occasionally occur while fumigating with this gas but no cases of dermatitis have been reported.

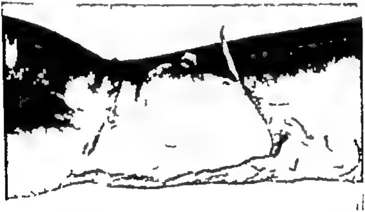

FIG. 52.—Dermatitis, desquamating stage due to ethyl mercury chloride in chemical worker

Compounds of mercury such as ethyl mercury chloride (Fig. 52) ethyl mercury phosphate hydroxy-mercuri-cresol hydroxy-mercuri nitrophenol and hydroxy-mercuri-chlorophenol are used to destroy insects and fungi on seeds and bulbs before planting. All of these compounds are skin irritants and will cause dermatitis if they are allowed to remain on the skin for any length of time.

Some of the chemicals used to moth-proof fabrics and to kill moths are skin irritants. Paranitrochlorbenzol paradichlorbenzol and ethylene dichloride are some of these.

Nearly all of the chemicals used to protect wood from termites are skin irritants. Sodium fluoride zinc chloride dinitrophenol the chlorinated phenols mercury bichloride tar and creosote are some of the chemicals used for this purpose.

The chlorophenols especially tetra and penta chlorophenols have lately come into use as wood preservatives and termite repellents.

DDT.—Dichlordiphenyl trichlorethane has become one of our most important insecticides. During World War II it was exten

sively used for delousing purposes by simply dusting the powder into the clothing. It is effective against mosquitos and flies although its knock down power is not as great as that of pyrethrum and some of the synthetics. A plant making DDT was inspected but no cases of dermatitis were seen among the exposed workers. Patch tests with the pure DDT powder performed on 200 volunteers showed mild reactions (+ 1) on 8 of them.

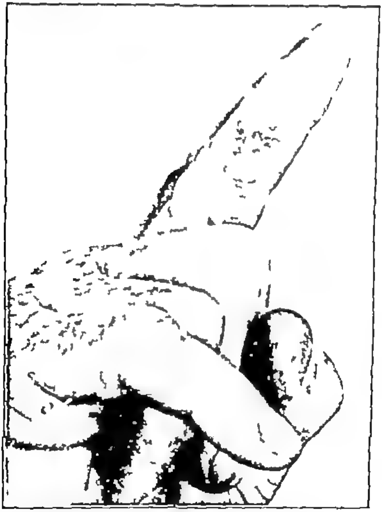

Fig. 53.—Dermatitis from prolonged contact with D.D.T. solution. (Courtesy of P. A. Lawrence.)

DDT when used in solvents has been reported as causing dermatitis but it is suspected that the solvent (deodorized kerosene) was the principal irritant. (Fig. 53)

The aerosol bombs containing about 5 per cent DDT in Freon have not yet been reported as causing dermatitis.

Insect Repellents.—The use of chemicals on the skin and clothing for the purpose of repelling insects is a comparatively recent development. Most of the insect repellents are also insecticides They have a selective action against insects . Dermatitis may occur from any of the insect repellents but it is usually of an allergic nature.

Mosquito and Fly Repellents

Pyrethrum—10 per cent in deodorized kerosene.
Diethyl and Dimethylphthalate—20 per cent in ointment.
Alpha dimethyl prime carbobutoxy dihydro gamma pyrone (1) *
Diethylene-sodium-muelthiocarbamate (2) *
Butyl carbitol thiocyanate + thiocyano ethyl laurate (3) *
Ethyl hexanediol (also gnats and chiggers)

Chiggers

Derris, pyrethrum sulphur equal parts dusted or sprayed on socks shoes and trousers.
Camphor menthol phenol and petrolatum equal parts applied to ankles, legs and thighs.
Sulphur 25 per cent in vanishing cream applied to skin

Ticks

Rotenone or hydrogenated rotenone 25 per cent in a lotion or vanishing cream applied to skin socks shoes and trouser legs

Pediculi acari

Dichlor diphenyl trichlorethane (DDT) also flies, roaches.
Benzyl benzoate.
(1) Indalone.*
(2) Dithane.*
(3) Lethane.*

INSECTICIDES AND FUNGICIDES

Inorganic.

Alum
Ammonium carbonate
Ammonium sulphate
Ammonium sulphide
Arsenic acid (corrosive on mucous membranes and broken skin)
Barium carbonate
Barium chloride fluosilicate
Bordeaux mixture (copper sulphate + lime)
Calcium arsenate
Calcium arsenite
Calcium chloride
Calcium cyanide
Calcium sulphate
Calcium sulphide
Calcium sulphite
Carbon disulphide
Chloride of lime
Chlorine
Copper acetate
Copper aceto arsenite (Paris green)
Copper arsenite (Scheel's green)

* Primary irritants in strong concentration.

Inorganic—(Continued)

Copper borate
Copper carbonate
Copper chloride
Copper cyanide
Copper fluoride
Copper sulphate (blue vitriol)
Copper sulphide
Eau Celeste (ammoniate of copper oxide in water)
Ferric chloride
Ferric hydroxide
Ferrous sulphate (green vitriol)
Hydrochloric acid
Lead arsenate
Magnesium bisulphite
Magnesium silicate
Magnesium sulphate
Mercuric chloride
Nickel sulphate
Nitric acid
Potassium carbonate
Potassium chloride
Potassium cyanide
Potassium nitrate
Potassium permanganate
Potassium sulphide
Potassium sulpho carbonate
Potassium sulpho cyanide
Sodium arsenite
Sodium carbonate
Sodium chloride
Sodium cyanide
Sodium fluo aluminate
Sodium hydroxide
Sodium nitrate
Sodium silico fluoride
Sodium sulphate
Sulphur
Sulphur dioxide
Sulphuric acid
Sulphurous acid
Zinc chloride
Zinc sulphate
Zinc sulphide

Organic

Benzol
Chlorobenzols
Chloroform
Chlorophenols
Coal tar*
Copper naphthenate
Creosote
Cresol*
Dimethylphthalate
Ethyl mercuric salts
Formaldehyde
Naphthalene

* Primary irritant in strong concentration

Organic.—(Continued)
- Nitrobenzene
- Phenyl mercuric salts
- Phenol
- Tetrachlorethane
- Turpentine
- Zinc naphthenate

Insecticidal Products

Synthetic
- Isobornyl thiocyano acetate (Thanite)
- Butyl carbitol thiocyanate (Lethane)
- Benzyl benzoate*
- Dichlordiphenyl trichlorethane (DDT)
- Alphanaphthyl isothiocyanate (Kanecocide)
- Beta thiocyanethyl laurate
- Methyl bromide
- Alpha dimethyl alpha carbo butoxy dihydro gamma pyrone (Indalone)
- Dimethyl phthalate
- Rutgers 612

Natural Plant Insecticides (Sensitizers)

- Pyrethrum
- Rotenone $\left\{\begin{array}{l}\text{Derris}\\ \text{Cubé}\end{array}\right.$
- Nicotine (systemic poison no dermatitis)
- Sabadilla seed
- Quassia extract
- Hellebore root
- Delphinium seed

Fungicides Used for Tropicalization

- Aniline mercaptobenzothiazole
- Copper acetate
- Copper naphthenate
- Copper palmitoleate
- Copper pentachlorphenate
- Copper oleate
- Chlorphenols
- Bromcresols
- Phenyl mercuric salts $\left\{\begin{array}{l}\text{acetate}\\ \text{benzoate}\\ \text{lactate}\\ \text{oleate}\\ \text{salicylate}\end{array}\right.$
- Nitrophenols
- Orthophenyl phenol
- Dihydroxy dichlor diphenyl methane
- Dinitro-ortho-cyclo hexylphenol
- Quaternary ammonium compounds such as alkyl phenoxy ethoxy dimethyl benzyl am. chlorides
- Cetyl dimethyl benzyl am. chlorides
- Salicylanalid

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CHAPTER XXVIII

DERMATOSES IN LEATHER MANUFACTURE

Affections of the skin are frequent among leather workers. Various authorities estimate that from 6 to 23 per cent of workers in tanneries suffer from occupational skin diseases. In New York State about 2 per cent of all reported cases of industrial dermatoses occur among handlers of leather.

Anthrax, the most serious of the hazards of leather manufacture, occurs in the form of malignant pustule. The large majority of the cases of anthrax occur among workers who handle uncertified hides from China or India before they are immersed in the solutions of lime or formaldehyde used to destroy anthrax germs and spores.

Manufacturing Process.—The fresh dried hides received in bales or the green hides from the slaughter houses are softened by soaking in water to which may be added small amounts of caustic soda or sodium sulphide. They are further treated by softening machines. They are then placed on a "beam" and excess flesh and fatty matter removed by scraping with a curved knife. The hair is then removed. In the case of short-haired animals whose hair cannot be used, the hides are soaked in a solution of sodium sulphide and lime until the hair is dissolved.* When the hair is long and is to be sold for the manufacture of felt, the flesh part of the hide is painted with mixtures of sodium sulphide and lime, arsenic sulphide, or calcium hydrosulphide. Such mixtures are called "rusma." After standing for a while, the hair can easily be rubbed off on the "beam" with a dull knife. Any remaining hairs are removed by soaking the hides in a solution of sodium sulphide.

Hair is sometimes removed by the putrefaction or sweating method. This is done by salting the flesh side of the hides or by sprinkling them with dilute acetic acid and then folding them with the hair side out and stacking them in tanks in a warm chamber. Fermentation sets in and after a suitable time the hairs are loosened and can be removed on the "beam." In small factories these operations are done by hand, and when proper rubber gloves are not used, dermatitis and sores caused by the lime (Figs. 54, 55 and 56), sulphide, and arsenic are common. The lime and sodium sulphide *on the hides combine to form sodium hydroxide and calcium sulphide* which are even more irritating to the skin than the original substances. In large factories there are unhairing and fleshing machines and dermatitis is less common.

After removing the hair, the hides are subjected to the action of enzymes to remove the gelatin and make them more permeable to tanning agents. The enzymes used are ammonium chloride and pancreatic extract (called "bate").

* A solution of dimethylamine may be used with this solution of lime and sulphide.

The hides are further de-fatted by immersing them in benzine kerosene or carbon tetrachloride the fat is recovered and used for soap making They are then pickled by immersion for about an hour in a solution of about 8 per cent salt and 1 per cent sulphuric acid washed in a solution of salt and then drained and ready for tanning The pickling solution may even contain higher percentages of sulphuric acid hydrochloric acid or formic acid

Fig 54.—Lime dermatitis on arm of hide unhairer Leather t aing.

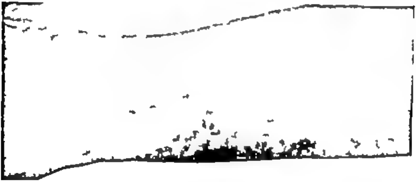

Fig. 55 —Dermatitis due t red arsenic used unhairing agent Lea her tanning industry

Dermatitis and lesions of the nails occur from the acid and strong solutions of salt used in the pickling baths

Tanning is done by a number of methods

1 *Infusion Tanning* which consists in pa sing the hides into tanning baths of increasing strength and occupies a period of ix to nine weeks

2 *Tanning in Layers* which consists in placing the hides in layers with tanning material between in a wooden tank until the tank i full then filling up the empty spaces with water and allowing the hides to soak for a period of months. This is done with sole leather

The vegetable tans such as sumac quebracho and nutgalls, are usually used in this process

3 *Rapid Tanning* is the modern method and is done in revolving drums with concentrated tanning baths prepared from active tanning extracts. It can be completed in two days.

FIG. 56.—Dermatitis due to Na_2S on an unhairer (Leather tanning

Soft leather used for gloves or clothing is usually given a "chamoising" or oil tan This is done by smearing and rubbing the skins with various mixtures of fats and oils such as fish oil wool fat paraffin egg yolk, and fatty acids. Alum phenol salt and resins may also be mixed with the fats. The tanning oil is repeatedly worked in until the tanning is completed and then the excess of fat is removed by washing the skin in a soda solution. Dermatitis is a rare occurrence among chamois tanners.

4. *Mineral Tanning* is done by two methods the single-bath and two-bath method

In the single-bath method the hides are placed in a solution of a basic chromium salt. This is done by treating a solution of chrome alum with soda, or by treating a solution of potassium bichromate with an acid and a reducing agent.

In the two-bath method the hides are first placed in drums in a bath of potassium bichromate and HCl 4 and 2 per cent respectively of the weight of the hides. After a sufficient length of time the drums are drained and filled with a second solution called the reducing bath. This consists of sodium thiosulphate 10 per cent by weight of the hides, and hydrochloric acid 5 per cent. The hides are revolved in this solution for a sufficient time and it is then drained and the hides removed

There are also a number of patented tanning compounds on the market Some are mixtures of chromium oxide sodium sulphate

sulphuric acid and aluminum sulphate; others, called "syntans," are prepared by condensing phenol sulphonic acid with formaldehyde or from amino and hydroxynaphthalene sulphonic acids.

Chrome ulcers and dermatitis occur among workers with these tanning solutions, especially if long rubber gloves, aprons, and rubber boots are not worn. The floors of the tannery are wet with irritating solutions and the work clothes are usually soiled. The acid bichromates are the active agents in causing skin irritations, particularly in the two-bath process.

After tanning, the skins are stretched, smoothed, and oiled (with various mixtures of fish, linseed, castor and Neats' foot oils, lanolin and egg yolk) to prevent cracking. While still damp, they are "toggled," which consists of seasoning with a mixture of titanium, casein, shellac, and formaldehyde. They are then dried, glazed, and pressed.

Hides are waterproofed by immersing them for a few hours in a bath of soap and glue and then in a solution of alum and salt, or by immersion in a 2 per cent solution of gelatin followed by a 5 per cent solution of formalin.

Chrome tanned leather can be waterproofed in an 8 per cent solution of aluminum sulphate containing 1 per cent of sulphuric acid. Dermatitis may occur in these processes from the formaldehyde and acid.

DYEING OF LEATHER

The dyes used on hides are those used for animal fibers. The basic, acid, and direct dyes are used. The tanning agents in the leather act as mordants. The dyes may be placed in the tanning solution or the leather may be dyed in separate vats, or the dye may be brushed on the leather (table method).

Dermatitis is rare among the dyers. However, aniline, Bismarck brown, chrysoidine, orthotoluidine, auramine, amino-azo-benzene, di-methyl amino-azo-benzene, and amino-azo-toluene hydrochloride have caused dermatitis among hypersensitive workers.

Dermatitis has been reported frequently from the wearing of leather objects such as shoes, wrist watch straps and the sweat bands in hats. In these cases the dyes or polishes or tanning agents were the most frequent causes.

The following list of leather dyes is taken from the Colour Index, Society of Dyers and Colourists.

Index No.	*Commercial Name*	*Description*
15	Amidoazobene	Brownish-yellow solution.
17	Amidazotoluol	Appearance, brown solution on heating.
20	Chrysoidine	Hydrochloride of benzene-azo-m-phenylenediamine or m-diamino-azo-benzene. Dyes leather an orange brown.

Index No.	*Commercial Name*	*Description*
71	New Phosphine G	Hydrochloride of dimethylaminobenzyl azo resorcinol. Dyes leather yellow
72	Tannin Orange	Appearance brown. Dyes leather a very bright orange.
145	Indian Yellow R	Appearance, dark yellow brown powder
146	Citronine Y cone	Appearance, reddish brown powder
148	Phosphine substitute (BDC), etc.	Appearance, brown powder Reddish yellow solution.
151	Orange II (ACC)	Appearance, bright orange powder Reddish yellow on solution in water
161	Orange R	Brick red powder. Reddish yellow solution.
192	Fast brown 3B	Brown powder. Brownish red solution.
230	Leather brown	Glistening blackish powder Brown solution.
234	Resorcin brown	Brown powder Brown solution
239	Fast brown	Brown powder Reddish brown solution
331	Bismarck brown G	Dark blackish brown powder Brown solution
332	Bismarck Brown R, etc.	Dark brown powder Reddish brown solution.
657	Malachite green cryst. A	Bluish green solution
662	Brilliant green cryst. Y	Appearance, small glistening golden crystals. Green solution.
669	Acid green	Brownish black powder Green solution
676	Para magenta	Glistening cantharides crystals. Crimson solution in alcohol
677	Magenta P pdr	Crystals. Red solution in alcohol
678	New Roseine O	Bottle-green powder Red solution. Dyes leather direct red.
787	Coriphosphine O	Reddish brown powder Orange yellow solution
788	Acridine Orange L	Orange colored powder Orange yellow solution.
788a	Acridine scarlet J pdr	Orange red solution
789	Brilliant Phosphine G 3G 5G	Light brown powder Yellow solution.
791	Benzo flavine No 2	Brownish orange powder Yellow solution in water Reddish yellow solution in alcohol.
793	Phosphine	Orange yellow powder Reddish yellow solution
794	Phosphine 2G	Brown powder Brownish orange solution in water Orange yellow solution in alcohol.
797	Euchrysine 2G 4 RR	Reddish yellow powder Yellow solution Used mainly for dyeing vegetable-tanned leather
798	Homophosphine G	Reddish brown powder Yellowish brown solution in alcohol Brown solution in water

Index No	Commercial Name	Description
799	Coriofiavine G	Red or reddish brown powders. Orange brown solution in water yellowish brown solution in alcohol.
824	Flavinduline O H	Brownish yellow to orange red powder Orange yellow solution
861	Induline water-soluble	Bronzy powder Blue solution in alcohol bluish violet solution in water
864	Nigrosine spirit-soluble	Grayish black powder Bluish black solution
910	Fast blue for cotton B 2B	Dark violet powder the dust of which exerts an extremely irritating action causing sneezing Blue solution
1231	Young fustic	Yellow solution.
1233	Quercitron (ground bark or extract)	Yellow Used for tanning and dyeing leather in one operation
1234	Persian Berries (crushed or extract)	Yellow
1237	Berberine—Barberry extract	Yellow solution Used formerly to a limited extent for dyeing leather Berberine possesses a bitter taste and is used medicinally as a tonic.
1250	Persian Berry Lake	Yellow to orange lumps, powder or paste. Yellowish brown solution
1253	Logwood black, blue black	Deep bluish black paste or powder Yellowish red to bluish red solutions.

In a survey of a number of tanneries, 505 workers were examined for dermatitis Twenty cases of occupational skin lesions were found including 2 cases of perforation of the nasal septum in master tanners who had worked for many years at chrome tanning One case of chrome ulcers and 1 case of chrome dermatitis were found The case of dermatitis admitted a long standing hypersensitivity to chrome and he stated that the dermatitis developed whenever he came in contact with it. (Fig 57)

One case of dermatitis of the exposed portion of the arms between the top of the rubber gloves and the bottom of the rolled up sleeve was found in a worker who dipped skins into the unhairing solution of sodium sulphide Two cases of dermatitis due to sulphuric acid were found in workers in the pickling room.

In one plant where red arsenic was largely used as an unhairing agent 2 cases of dermatitis due to arsenic were found

There were 11 cases of ulcers of the hands among workers who handled lime Dermatitis due to dyes was not found

Workers who stretched and pinned the skins to the frames were found to have scratch marks and bruises on the fingers from the pins and metal frames To protect their fingers they often wound adhesive and friction tape around the fingers and dermatitis sometimes developed due to the irritants in the plaster and tape

Leather pressers have been known to contract dermatitis from the fumes given off by the hot iron as it comes in contact with the leather. It is possible for the heat of the iron to decompose some of the dyes used on leather into their intermediates or into other irritating compounds which are volatilized and thus come in contact with the skin.

The stakers and glazers have callosities on the dorsal surfaces of the knuckles from constant contact with the machines.

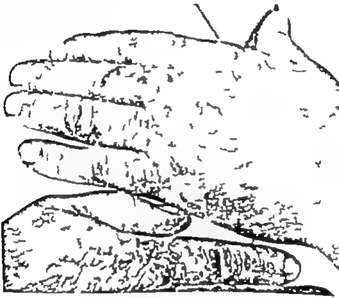

FIG. 87.—Chrome acid dermatitis in tannery laborer. (Case of Drs. Forrester and Warder.)

It is difficult to determine the exact chemical which causes the ulcers and dermatitis in any one unhairer because any of the chemicals used for unhairing may be the cause and the lesions caused by them are alike. However, it is the general opinion that the lime is more likely to cause ulcers and the sodium sulphide and arsenic the dermatitis. The ulcers caused by lime and chrome are similar in appearance and the actual cause can only be determined if it is known that the worker handles only one of these substances. The ulcers are punched out, round or oval, occur on the back of the hands or fingers, and may only have a narrow inflammatory halo. They are difficult to heal while the patient is working. Curetting the base, covering them with an antiseptic ointment, and protection against further exposure to the irritant are necessary for a cure.

PREVENTION OF DERMATOSES IN LEATHER MAKERS

Anthrax is usually caused by handling uncertified hides from foreign countries before they are immersed in the lime or other antiseptic solution.

Workers who handle raw hides should work with rubber gloves and boots and should be warned against scratching their skins or even touching their faces without first cleansing the hands.

Unhairers should wear long rubber gloves aprons and boots to prevent the unhairing chemicals from touching the skin If the gloves or boots are defective dermatitis and burns may occur

Acid burns in the pickling room can be prevented by the same means

Chrome sores were more common among tanners before the introduction of automatic tanning drums Formerly the skins were immersed and taken out of the tanning solution by hand Now they are revolved in tight tanning drums and the excess of tanning solution drained off before the skins are taken out Nevertheless rubber gloves aprons and boots should be worn by all workers handling hides.

Shower baths should be available and the workers compelled to use them after work. Work clothes should be frequently washed and changed since irritating chemicals in soiled clothes are a frequent cause of dermatitis

ARTIFICIAL OR PATENT LEATHER

These substances rarely contain any leather They are made of cotton fabrics covered by a thick solution of cellulose nitrate in ethyl alcohol ethyl acetate, castor and cotton seed oils.* A gluey solution may also be spread or pressed into cotton and the surface treated with formaldehyde solution to make artificial leather Rubber solutions may be used instead of glue Artificial leather can also be made by cutting scrap leather into fibre mixing it with linseed oil and compressing it into sheets. Imitation grains of different leathers are put on the surfaces of these artificial leathers by passing them through embossing machines or by means of engraved press plates

Dyes and pigments are used to color artificial leather and dermatitis sometimes results among the workers who prepare the pigments and dyes due to sensitivity to the dyes or their solvents Dermatitis may also result from formaldehyde and the solvents used for dissolving the cellulose nitrate one of the ingredients of artificial leather

DERMATITIS CAUSED BY WEARING AND HANDLING LEATHER GOODS

Dermatitis from wearing leather goods such as the sweat bands of hats wrist watch straps shoes, and gloves is occasionally reported. In Ohio in 1934 18 cases of occupational dermatitis due to handling leather goods were reported to the State Labor Department.

* It is sometimes made by treating real leather with oil and varnish and baking and polishing it.

The dyes in the leather are usually blamed but it is obvious that any of the other chemicals used to convert hides into leather may be the cause. Sufficient amounts of these chemicals may be dissolved out of the leather by water or perspiration to cause dermatitis among sensitive individuals. That these quantities are too small to affect normal skins is shown by the fact that such dermatitis is rare among the millions who wear leather goods.

When leather is suspected to be the cause of a contact dermatitis the following procedure should be carried out. Determine whether the material is artificial or real leather. If artificial, the cotton can be seen by tearing it. If it is real leather, moisten a piece ½ inch square with the perspiration of the patient (obtained from the axilla) or with a solution approximating the perspiration in composition and perform a patch test on a clear portion of the patient's skin, if possible close to the site of the eruption, leaving it on for forty-eight hours. A positive reaction establishes the fact that the patient is sensitive to something in the leather. If it is suspected that the leather has been soiled by urine, as may be the case when the dermatitis is supposedly caused by a child's shoe, moisten the leather with the patient's urine and apply as a patch test. Always use control patches.

To determine whether the dye in the leather has caused the dermatitis, soak a piece of the suspected material in a test-tube of the synthetic perspiration or urine, as the case may be. Leave it in for about one-half hour and note if the solution is discolored by the leather. If it is, the dye is said to "bleed" and may be the cause of the dermatitis. To confirm this, soak a piece of gauze in the solution discolored by the leather (after the solution has been concentrated by evaporation on a water-bath to a fraction of its original volume) and apply as a patch test for forty-eight hours. A positive reaction shows that the patient is sensitive to the dyes in the leather. A negative patch test to the dye and a positive one to the dyed leather implicates the tanning, unhairing or finishing chemicals.

If the finishing oils or fats are suspected, soak a piece of the leather in ether for about fifteen minutes and then pour the ether on a watch glass or porcelain plate and allow it to evaporate and leave any fats dissolved out of the leather. Smear a piece of gauze in this fatty deposit and perform a patch test. If the tests with fats and dyes are negative and the finished leather patch is positive, then the hide itself or the tanning or unhairing agents are at fault. To prove this, soak the leather in water and heat gently to about 100° F. for about fifteen minutes. If the water is discolored, remove the leather and place it in a fresh test-tube of water and repeat until the solution is no longer colored by the leather. This removes the water-soluble dyes. Allow the leather to dry and then soak in a test-tube of ether for fifteen minutes. Repeat with fresh ether until no more fat is left on evaporating the ether. Allow the leather to dry and moisten it with perspiration and perform a patch test on the patient with it

A positive patch test implicates the tanning unhairing chemicals or the hide itself as in the case reported by Gougerot and Delay

If it is possible to trace the leather to the factory patch tests can be done with the leather in different stages of manufacture and with the various chemicals and dyes used Tracing the actual irritant has been done by Beerman in the case of hat band dermatitis and by Schwartz in cases of wrist watch strap dermatitis

Negative reactions to the patches described above make it highly probable but not absolutely certain that the leather has not caused the dermatitis. The small degree of uncertainty is due to the fact that there are variations from time to time in the sensitivity of the patient due to the fact that the friction incidental to the wearing or handling of the leather may play a rôle. This friction is absent in the patch test

The following are some of the substances contained in the finished leather which may cause dermatitis among sensitive individuals Chromates sulphides arsenic, formic acid sumac oak, quercitron fish oil castor oil egg yolk resins and dyes such as Bismarck brown chrysoidine amido-azo-benzene amido-azo-toluene hydrochloride dimethyl amido-azo-benzene orthotoluidine phosphine and nigrosine

Dermatitis has been reported due to shoe creams and polishes *There are many formulas for this purpose. They may contain some* of the following skin irritants Oxalic acid aniline hydrochloride formalin white arsenic, Bismarck brown oil of turpentine other oils and resins

If the suspected material is artificial leather then treatment with solvents such as ethyl alcohol ethyl acetate toluol etc will dissolve the celluloid or glue in the fabric and patch tests may be performed in a manner outlined above to determine the actual irritant

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CHAPTER XXIX

LIQUOR INDUSTRY

ALCOHOLIC liquors may be grouped in three divisions according to the process of production (1) Fermented liquors or wines, in which the fruit sugar is converted into alcohol aerobically by saccharomyces normally present on the fruit (2) Malt liquors such as beer ale and porter which require the preliminary operation of malting to convert the grain starch into sugar before alcoholic fermentation can take place (3) Distilled liquors such as whiskey gin and brandy in which the alcoholic content of the fermented liquor of fruits grains etc is increased by distillation

WINE INDUSTRY

Wine is the product of fermented grape juice or "must" which consists of the crushed fruit in water The "must" is fermented in large vessels or vats during which process the glucose or sugar is decomposed and converted into alcohol. The alcohol dissolves in the fermenting liquid while the carbon dioxide also formed passes out into the air of the workroom

When the wine has matured it is emptied and barrelled by the *cellarman* *The marc or residuum is pressed* and the liquor undergoes a second and slower fermentation in the barrels and again results in the formation of alcohol and carbon dioxide When the wine has been clarified racked (drawn off from the lees) and fined it is poured into casks and bottles ready for marketing

The atmosphere of the workrooms is humid usually dark and not always adequately ventilated

While alcoholism from drinking is prevalent in this industry intoxication has also been observed due to absorption of alcohol *through the skin and the respiratory tract* *Occupational alcoholism* is most frequent among the bottlers and next among cellarmen who rack the wines Fumes are given off by the liquid as it flows into the bottles and bubbles of carbon dioxide when the wine is distributed in racking Volatile ethers may also cause intoxication Both chronic and acute forms occur among winemakers who work in hot closed rooms, but the occupational poisoning is increased by habitual drinking

Skin injuries and infections arise during practically all stages of winemaking Vineyard workers are exposed to much the same conditions as agricultural laborers (q v) Epidemics of dermatitis have occasionally been reported due to the bites of *Ixodes ricinus* the lesions taking the form of blackish blisters

Hypersensitivity to grape juice may exist and has been demonstrated by the appearance of a pruritic macular eruption on the

hands and arms twenty-four hours after contact In the case reported however there is a history of eating a quanity of grapes, both fresh and preserved. (See Chapter on Plants and Woods.)

Among cellarmen a characteristic dermatitis is produced by alcohol and tannins present in the "must lees, marcs, and wines. The hands are macerated by continual immersion in these liquids and the alcohol and tannin coagulate the skin proteins causing the skin of the hands and forearms to become blackened dry hard and cracked. Sometimes the skin is covered with deep and painful sores

Formic acid which is a secondary product of wine fermentation is sometimes used as a substitute for lactic acid in the fermentation of alcohol. It may cause blisters and ulceration in strong concentrations. It has also been used to sterilize wine-making apparatus. However its use is prohibited in this country

Sulphuric acid used to correct faults in the wine and for sulphuring vats and barrels may produce corrosion of the skin and inflammation of the mucous membranes of the eyes and respiratory tract

Cooperage *i e* the making of barrels kegs, and casks, including the construction of vats tubs and other wooden receptacles, creates large amounts of sawdust whether the operations are done by hand or by machinery There is also the possibility of dermatitis from certain woods among sensitive persons (see Chapter on Plants and Woods) although a more common source of irritation is the mechanical action of the fine hard particles of sawdust containing tannins. The dust also causes dryness of the mucous membranes coughing and catarrhal symptoms

Barrel staves are softened in hot water or steam to make them pliable The water in which they are steeped becomes blackish and full of tannin from the wood Workmen who put their hands and arms in the water or handle the damp staves contract the same skin lesions as previously described from the action of tannin.

The casks are sometimes coated inside with a thin layer of paraffin to make them waterproof The paraffin is melted in heated cauldrons and during this process the fumes may cause conjunctivitis and irritation of the respiratory passages

Lead poisoning has been reported from painting the barrels with a *mixture of white lead and turpentine*

Burns may occur from contact with heated vessels and from boiling water or steam in the process of softening the staves. Broken bottles frequently cause wounds.

Although *Aspergillus niger* is a common parasite on California grapes destroys many grapes and often creates a fine black dust in wineries it does not affect the human skin.

BREWERIES

The basic materials used in making beer and related beverages (ale porter etc) are barley hops yeast ice, and water Other

cereals such as oats corn (maize) and rice are sometimes substituted for barley and glucose or invert sugar may be used as an adjunct or partial substitute for malt Hops provide the bitter flavor characteristic of beer and also act as a preservative

The barley or other cereal is cleaned sorted then steeped in tanks and made to germinate in a hot damp atmosphere It is then dried by exposure to air or in kilns heated by hot air or gases. The resulting product is malt The preparation of malt may be done at the brewery or in a separate malting house

The grain in the kilns is stirred by hand or by an automatic mechanism inside the kiln To color certain beers, the malt is roasted in sheet metal containers directly over a flame.

Hops must be carefully selected and properly dried to prevent infection with molds This is done either on screens in the open air or in the oast house For further preservation hops are exposed to sulphur vapor compressed and put up in watertight bags.

The wort or mash is derived from the crushed malt and hops dissolved in hot water The mash is brought to a proper temperature to ensure saccharification either by infusion or decoction Infusion is commonly employed in the process known as top fermentation Decoction or boiling of the mash is used in "bottom fermentation

The hot wort is then cooled in the open air or by refrigeration Yeast is added and the wort undergoes fermentation in vats placed in cellars which are kept cool with ice or refrigerating pipes Additional fermentation takes place after the beer has been barreled

The processes of malting and brewing subject the workmen to extremes of heat and humidity The temperature of the rooms ranges from 158° to 176° F (70° to 80 C) In the cooling rooms the temperature remains between 34 and 41° F (1° and 5° C) In both departments the humidity is high There is a high incidence of rheumatic affections among the workmen.

In small breweries, the same workmen may have to carry on the various operations and go from superheated workrooms to those that are nearly at the freezing point These changes of temperature together with the chronic alcoholism common among the workers cause a high rate of mortality from tuberculosis and other respiratory diseases.

In plants not equipped with modern machinery the men rake the malt make the mash wash the filters tar and wash barrels wash and label bottles and carry blocks of ice sacks and barrels etc.

Great quantities of carbon dioxide are given off during germination of the barley in the malt houses and in the fermenting vats and cellars. Asphyxiation from this source is a grave danger to the workmen

Combined heat and humidity in malting and brewing may cause typical heat rashes and other affections of the skin Humidity and cold in the refrigerating chambers and from the transportation of ice may cause pernio if the extremities are not well protected (See

Chapter on Physical and Mechanical Agents for other possible effects of heat and cold)

The workmen are subject to burns from heated vessels and tools or from open fires in drying the malt over flames and from boiling liquids in the process of brewing Where electrical machines and equipment are used burns may occur from defective insulation. The escape of ammonia under pressure from refrigerating pipes may severely burn the skin (See Refrigeration)

While sorting and cleaning the barley preparatory to making malt, the workmen may contract 'barley itch' due to the acarus *Sphærogyna cerealella* which may infest the grain This mite causes an itchy desquamating scarlatiniform erythema with vesicles and wheals that often become confluent and cover all the exposed surfaces of the skin

A great quantity of dust is disseminated during manipulation of the dry grain and maltster s itch from this source has been observed especially in the hot and humid rooms. The lesions consist of small itchy papules topped by tiny vesicles, with exudation excoriation and crusting In some cases follicular pustules form.

Manipulation of hops may give rise to dermatitis caused by the irritant action of their volatile oils. A pruritic papular eruption has been reported from putting chapped hands into a bin of hops. Moreover the essential oil is sometimes extracted and added to beer to give additional flavor and aroma, and contact with this liquid is even more likely to cause dermatitis.

Brewery workers who scrape masses of yeast from the fermenting vats with their fingers may develop a mycotic infection characterized by crusted excrescences beneath the nails which become riddled with lacunæ and are eventually destroyed.

Bottling labeling bottle washing etc. are now generally done by machinery although in some small plants these may still be done by hand In such cases, bottle washers are subject to *Erosio interdigitalis blastomycetica* from maceration of the skin by water and infection with a yeast-like organism

Workers who scrape labels off bottles suffer from onycholysis Black spots appear under the nails and rapidly involve the whole nail which becomes loosened and discharges a slight serosanguinous fluid This is believed to be due to maceration by water plus mechanical injury to the edges of the nails in addition, the paste may be a factor

When glucose and invert sugar are employed in the making of beer they may be contaminated with arsenic derived from the acid used in their preparation from starch and cane sugar respectively Arsenic which thus contaminates beer has been responsible for numerous cases of poisoning among consumers (workmen and others) Besides the constitutional symptoms, which often prove fatal a large proportion of the cases present various skin lesions such as erythema herpes pigmentation and bullæ

Cooperage is an important part of the activities of a brewery

To protect the beer and to avoid leakage the barrels are coated inside with pitch or an alcoholic varnish and must frequently be repaired and recoated Pitch i applied either directly or by hot air or steam The vapors given off from the pitch are capable of exploding when mixed with air When applied by hand the workman is subject to injury from the fumes and to dermatitis from contact with the melted pitch

Methyl alcohol used as a paint solvent may cause irritation of the skin

Chemicals used as disinfectants and preservatives may cause skin lesions. Dermatitis and destruction of the fingernails can result from contact with *formaldehyde* In Prussia Antiformin which consists of a resin dissolved in a mixture of pyridine acetone etc has caused poisoning among brewery workers. *Phenol* may produce eczema and erosion of the skin. Irritation of the eyelids conjunctivitis ulceration of the nasal and buccal mucous membrane and ulceration erosion and vesiculation of the skin may result from contact with *hydrofluoric acid* *Nitric acid* which is used for cleaning the hop-back (an iron or copper vessel in which the mash is placed to let the hops settle) is capable of causing severe burns. *Formic acid* is used in Europe to sterilize pipes, vats etc Its use i prohibited in the United States.

Breakage of bottles which is very frequent in this industry results in many cuts and scratches, especially among workers in the store department

DISTILLED LIQUOR

Distilleries employ many of the processes described for brewing and fermenting but go on further to vaporize and condense the fermented liquor in order to concentrate the alcoholic content

The ingredients used to make whiskey are corn (maize) wheat rye barley malt fruit potatoes and other vegetables Generally raw grain is ground and mixed with hot water and malt to make the mash and brewers yeast added to the mash to produce fermentation The fermented mash is technically known as wa h and from this the spirit is separated by distillation Aging of whiskey takes place in oak barrels which have previously been charred or treated to coat them with tannin

In America most whiskey is made with the Coffey or patent till The wash is spread in thin layers over a large urface and heated by steam from an external boiler The still is a vertical structure consisting of two columns the rectifier and the analyzer both of which are subdivided horizontally by a series of perforated copper plates. The wash is pumped in at the top of the rectifier and trickles down through the plates to the bottom and then to the analyzer where it is discharged onto the first plate The steam enters from the bottom of the analyzer and bubbles upward through the perforations When the wash reaches the first plate of the

analyzer it cannot pass through the perforations because of the pressure of the steam whose continuous upward discharge gradually separates the alcohol and other volatile constituents. These are carried with the steam back to the rectifier where they are condensed The temperatures of the chamber of the rectifier are successively cooler from bottom to top. This results in the separation of the condensed liquor into various fractions

To make Scotch and Irish whiskeys direct heat is applied to a large volume of wash in the old-fashioned 'pot' still Peat which is used as fuel in drying the malt imparts the smoky taste characteristic of these whiskeys

Other products of distillation are brandy from wine or the lees of wine rum from sugar cane gin from the usual grain mash to which have been added various flavoring materials (in America juniper berries are extensively used) liqueurs and cordials, from rectified (redistilled) alcohol refined cane sugar and aromatic herbs seeds and fruits

Since the preliminary processes are similar to those described in the manufacture of beer and wine, the same skin hazards are encountered in distilleries. In addition the following aromatic and flavoring agents in gin liqueurs and cordials may produce dermatitis (see Spices and Flavoring Agents, and also Chapter on Plants and Woods)

Angelica	Fennel
Anise	Grains of Paradise
Bitter almonds	Lemon peel
Bitter orange peel	Mace
Caraway seeds	Nutmeg
Cassia bark	Orange peel
Cinnamon	Orris root
Cloves	Turpentine
Curaçoa orange peel	Vanilla

CHAPTER XXX

DERMATOSES CAUSED BY PAINTS, VARNISHES AND LACQUERS

PAINTS

Dermatitis among painters constitutes about 3 per cent of all compensated cases of occupational dermatoses. The occurrence of dermatitis is most frequent among painters in the building trades where the precautions are not as well observed as they are in factories.

Paint consists essentially of a suspension of a pigment in a drying oil. To this are added compounds of lead, manganese, or cobalt to accelerate the drying and turpentine or turpentine substitutes to thin the paint and facilitate its application.

Paints are manufactured by mixing an oil with a pigment in a mixing machine and then grinding the mixture with driers into a butter-like paste in special grinders. Thinner and oil are then added and the paint is ready to be placed in containers and shipped.

Oils Used in Paints and Varnishes.—The drying oils have the property of drying or oxidizing in air to form a tough elastic film of diperoxylinolenic acid.

Linseed oil is the principal drying oil used in paints. It is a mixture of tri-glyceride of linolenic, linolic, and oleic acids plus small quantities of the glycerides of palmitic and stearic acids. Linseed is obtained from flax (*Linum usitatis simum*) and the linseed used for the manufacture of drying oil contains considerable percentages of rape and mustard seeds. The oil is extracted by crushing and heating the seed into a mealy consistency and then placing the meal in filter hair cloths (sometimes made of human hair imported from China) through which the oil is expressed in powerful presses, leaving a residue of oil cake. This can be further treated with solvents such as carbon bisulphide, carbon tetrachloride, or benzol to remove more oil. The solvents are distilled, leaving the oil. The remaining cake can be used as fertilizer or cattle feed.

Dermatitis has been reported among workers who handle the linseed (Fig. 58.) The rash occurs on the hands, arms, and thighs. It is symmetrical and consists of discrete macules, papules, scratch marks, and crusts. The rash can be caused by the dust of the seeds, their sharp pointed ends, and by a pediculoides found on the flour beetle (*Tribolium ferrugineum*) and saw-toothed beetle (*Oryzaephilus surinamensis*), both of which are found in the linseed. The beetle which crawls on the skin causes itching but the pediculoides on the beetle actually attacks the skin and causes a scabies-like eruption. The workers on the extraction presses also develop a dermatitis due

to sensitivity to the oil. This may be due to the action of the contaminating oils of mustard and rape or as Frank S Pedley thinks, to the irritation of the skin caused by the custom of wiping the hands and arms with rough burlap sugar bags in which the linseed is shipped The men who strip the hair cloth filters from the pressed cake develop sore and inflamed fingertips from cuts by the coarse hair It is said that linseed from India causes more dermatitis than linseed from South America and that linseed from the United States and Canada causes the least

Fig. 59.—Linseed oil dermatitis.

Tung oil or China Wood oil is a drying oil used in paints and varnishes almost as much as linseed oil It is obtained from the seeds of the *Aleurites cordata* a tree cultivated in China and in some of our Southern States. According to the United States Dispensatory Edition No. 22 Tung oil has been used in the treatment of ulcers and skin diseases. Herthern however has reported that the seeds are highly toxic when eaten and that the oil produces dermatitis. It has been observed that human beings who eat the seeds suffer gastro-intestinal irritation and that cattle who eat the pressed cake (after the oil has been extracted) develop symptoms of poisoning Skin hypersensitivity to Tung oil may occur and dermatitis among painters due to this oil has occasionally been reported It seems that the oil from some species of the tree contains toxic substances while the oil from other species is harmless.

Japanese Wood oil obtained from *Paulownia imperialis* is similar to China Wood oil but is not extensively used

Other drying oils occasionally used in paints and varnishes are

Castor oil obtained from the seeds of *Ricinus communis* grown in tropical countries The husks of the seed contain a poisonous

substance called *ricin* which has caused dermatitis among workers on the oil presses and which renders the pressed cake unfit for cattle food

Perilla oil obtained from the seeds of *Perilla ocimoides* growing in China and Japan

Soya bean oil an edible oil obtained from the *Glycine hispida* grown in China and Japan.

Poppy-seed oil obtained from the seed of the opium poppy (*Papaver somniferum*) and used in artists colors.

Walnut oil, *Candlenut oil* *Niger oil* *Sunflower oil* *Hempseed oil* *Rape seed oil* *Resin* and *Pine oils* are other drying oils of vegetable origin occasionally used in paints.

Fish oil is obtained from menhaden, a herring-like fish

Dryers.—The drying of paints can be accelerated by the addition of small quantities of metallic oxides and salts.

The most important inorganic driers are Litharge red lead lead borate and the oxides, borates and sulphates of manganese The linoleates of lead cobalt and manganese lead acetate lead resinate and manganese oxalate are the most important organic salt driers They have not been reported to be the cause of dermatitis.

Pigments.—The coal tar dyes and metallic chromates are extensively used as paint pigments. The dyes are first made to react with an acid solution of sodium nitrate and then coupled with beta naphthol to form an insoluble compound which is called a "toner" Soluble dyestuffs are also precipitated on a lead or aluminum base by means of a mordant and are called "lakes."

Lead chromates are made by melting ingots of lead and dumping the molten metal into water forming "feathered lead" This is then acted on in tanks by acetic or nitric acid to form lead acetate or lead nitrate This is then reacted with a solution of potassium dichromate and "chrome yellow" is produced The various amounts of lead acetate and nitrate which are allowed to react with the potassium dichromate determine the shade of orange or yellow

Although observers have noted the occurrence of skin lesions caused by chromates among makers of chrome pigments in a large factory in New Jersey employing 350 men at pigment making the authors found no cases of dermatitis or chrome ulcers of the skin or nose. The men came into intimate contact with the chromates during the filtering and drying processes but were protected by rubber gloves and respirators

Prussian blue is made by mixing solutions of ferrous sulphate and sodium ferrocyanide and then oxidizing by the addition of sodium bichromate

There are a great many pigments used in paint but they are rarely the cause of dermatoses. Following is a list of the principal paint pigments

White Pigments

White lead or basic carbonate of lead—$2\,PbCO_3.Pb(OH)_2$
Basic lead sulphate—$PbSO_4.PbO$
Zinc oxide—ZnO
Titanium dioxide—TiO_2.
Lithopone—{ Zinc sulphide ZnS / Barium sulphate $BaSO$
Zirconium oxide—ZrO_2.
Antimony oxide—Sb_2O_3.
Calcium sulphate—$CaSO_4$.
Calcium carbonate—$CaCO_3$.
Silica—SiO_2.
Magnesium silicate—$Mg_3H_4Si_4O_{12}$.
Aluminum oxide—Al_2O_3.
Whitewash This consists of slaked quicklime mixed with water and splashes of it irritate the skin

Red Pigments (Inorganic)

Red oxide of iron—Fe_2O_3, also sienna and umber which depend on the red oxide of iron for tinctorial properties.
Red lead or minium—Pb_3O_4.
Cadmium sulphide—CdS
Cadmium selenide—$CdSe$.
Cadmium sulpho-selenide.
Red oxide of mercury—HgO
Mercuric sulphide (vermilion)—HgS

The coal tar dyes are extensively used in red paints. They are precipitated as lakes on a lead or aluminum base by the aid of a mordant. Hypersensitivity to some of the coal tar reds is occasionally encountered. The principal coal tar dyes used in paints are

Paranitraniline red	Colour Index No 44
Lithol red 2G	Colour Index No 166
Toluidine red	Colour Index No 69
Alizarine	Colour Index No 1036
Rosine	Colour Index No 771

Yellow and Orange Pigments (Inorganic)

Lead chromate—$PbCrO_4$.
Zinc chromate—$ZnCrO$
Barium chromate—$BaCrO_4$.
Cadmium sulphide—CdS.
Tin sulphide—SnS_2
Yellow oxide of mercury—HgO
Realgar or arsenic disulphide.
Orpiment—a mixture of arsenious oxide and arsenic trisulphide.
Lead antimonate—$Pb_3(SbO_4)_2$.
Potassium cobalt nitrate—$K_3Co(NO_2)_6$

Among the various yellow coal tar lakes and dyes used in paints only Oil Yellow Colour Index No 17 has been reported to cause dermatitis.

The chromate pigments are reported to have caused dermatitis among painters but the authors have not seen one case due to these pigments among many hundreds of painters examined

Green Pigments

Chrome green hydrated chromium oxide
Emerald green and Paris green—aceto arsenite of copper
Green earth—hydrated silicate of magnesium and aluminum
Mixtures of yellow and blue pigments such as lead chromate and Prussian blue.
Coal tar dyes.

Blue Pigments

Prussian blue—ferric ferro cyanide, Fe $(Fe(CN)_6)_3$.
Cobalt blue—Co_3O_4.
Coal tar dyes.

Black Pigments

Iron oxide
Carbon black.
Bone black.
Ivory black.
Lamp black
Vegetable black
Iron salts of coal tar dyes.
Metallic powders are also used as colors in paints.

Bronze powder is made by melting copper in an open pot and adding small amounts of zinc and aluminum to make an alloy The molten alloy is allowed to cool in thin plates which are passed through a series of stamp machines and then beaten in a long series of hammer machines into a fine powder The powder is polished screened and blended to various shades. The powder is then mixed with amyl acetate to form a paint. In hot weather the workers who make metallic powders are exposed to the dust of the alloy and develop a dermatitis which usually affects the axilla groin scrotum and neck It is rarely severe and frequent baths with change to clean work clothes in most cases suffices to alleviate the condition and permit the continuance of work

Fillers.—These are substances used to give paints properties other than that of tinting or opacity They are inert substances and have not been reported to cause dermatitis The common fillers are

Barytes and Blanc fixe ($BaSO_4$)
Whiting—consisting of ground chalk dispersed in water
China clay or kaolin a hydrated aluminum silicate.
Silica.

Thinners.—These are volatile substances which are added to paints to thin them to permit easier application as well as to hold in solution the oils and resins which the paints contain After the paint is applied the volatile solvents evaporate and leave only the solid constituents of the paint

The fat solvent property of the thinners is sufficient in itself to make them skin irritants and a large percentage of dermatoses caused by paints is due to this class of substances Many of the volatile solvents have skin-irritating properties aside from that of dissolving the fats of the skin

Turpentine was at first the only thinner used in paints, but the

rise in cost of this solvent caused the use of substitutes many of them petroleum or coal tar distillates Most of the cases of dermatitis reported to be due to paints were caused by turpentine or its substitutes. (Fig 59)

Turpentine is a pine tree product derived from various sources and its skin irritating properties vary with its origin. (See Chapter on Turpentine) Zitzke has reported 14 cases of dermatitis in a paint shop 12 yielding positive patch tests to hydroterpin obtained by hydrating German Pine oil.

The chief petroleum distillates used as turpentine substitutes in paints are white spirit gasoline, benzine mineral spirits, naphtha and petroleum ether All of them cause dermatitis if allowed to remain on the skin for a sufficient length of time

Fig 59 —Occupational dermatitis in a painter (Collection of Dr Howard Fox.)

The coal tar distillates used in oils are benzol toluol tetralin (prepared by the action of hydrogen on naphthalene) and dekalin (prepared by hydrogenation of tetralin) R. Prosser White reports dermatitis from both tetralin and dekalin

Any of the paint thinners can irritate the normal skin if allowed to remain on for a sufficient length of time as for instance in a patch test However such a long exposure seldom occurs among painters and only those develop dermatoses who are hypersensitive to the action of the solvents or to any of the solid constituents of the paint To determine which part of the paint causes a given case of dermatitis a piece of gauze should be soaked in the paint allowed to thoroughly dry and then applied to the skin as a patch test If no reaction results then another piece of the gauze wet with the paint and thinner but not allowed to dry can be applied In most instances it will be found that the dry paint is innocuous and that the wet paint is the irritant If it should be found that the dried paint gives a positive reaction then each solid ingredient of

the paint must be applied in a patch test to determine which is the offender

If the thinner is found to be the offender as is usually the case its composition can be determined by inquiring of the manufacturer of the paint Often the thinner is a turpentine substitute consisting of mixtures of the various volatile solvents with perhaps a small amount of pine needle oil to simulate the odor of turpentine

Paint Removers.—These often cause dermatitis if allowed to come in contact with the skin They usually consist of strong acids such as sulphuric and nitric A cyanotic condition of the hands has been reported by Crolnick in a worker using oxalic acid to remove paint Caustic soda is also used as a paint remover

Dioxan (diethylene oxide) used as a thinner and a paint remover may cause irritation of the mucous membrane and systemic poisoning

VARNISHES

Varnishes are essentially solutions of a resin in a volatile solvent which dry on exposure to the air leaving a hard film A dye may be added to this solution.

In addition to the resin and the volatile solvent an oil varnish contains a drying oil a drier and a thinner

Insulating varnishes may contain mica, porcelain chlorinated rubber and pitch in addition to the essential ingredients

Any of the natural or synthetic resins may be used in varnishes. (See Chapter on Resins.)

In making oil varnishes, the gum or resin is melted in large open kettles the oil (usually China Wood or linseed) is slowly added and the mixture is cooked until a smooth solution results The driers (lead cobalt manganese etc.) are then added and thoroughly incorporated The solution is then allowed to cool and forms the base varnish This is then thinned down with a volatile solvent and stored for a number of months before it is placed in cans.

In a chemical factory employing about 1,200 men of whom several hundred were engaged in making synthetic resins paints and varnishes there occurred only 2 cases of occupational dermatitis in the course of one year and both were due to toluol Two others who charged the kettles with the chemicals necessary to make a synthetic resin stated that occasionally they developed mild dermatitis of the hands from phthalic anhydride

Dermatitis has often been reported among users of varnish or varnished objects Japanese lacquer has been the irritant most often reported

Japanese and Chinese lacquer are obtained by tapping a tree (*Rhus vernicifera*) indigenous to those countries. It contains a toxic ingredient, urushiol which often causes dermatitis and even symptoms of systemic poisoning among those who come in contact with it. For this reason it is no longer used commercially in the United States.

The phenol formaldehyde resins in varnish have been reported to cause dermatitis Blumenthal and Jaffe described 7 cases of eczema among workers in a factory where they found by patch testing that the irritant was the phenol in bakelite varnish.

Schwartz and Poole reported an outbreak of dermatitis in cotton mills which they showed by patch tests was due to hypersensitivity to chlorinated ceresin and cumaron resin ingredients of a varnish used on the heddle frames of the looms. Goodman reported a case of lichenified eczema of the scalp caused by wearing a lacquered hair-pin

The volatile solvents, however are the chief potential irritants and poisons in varnishes and lacquers. There are over a hundred of them and some of them are poisons skin irritants, and sensitizers as well as fat solvents. They consist of acetates, ethers ketones coal tar distillates, chlorinated hydrocarbons, and other compounds. (See Chapter on Solvents.) The fumes of many of them irritate the mucous membranes causing conjunctivitis, rhinitis headache and dizziness or jags.

Kruger reports such symptoms among workers who apply nitro-lacquers to straw hats when the solvents used are butyl alcohol and butyl acetate

The authors have seen dermatitis in various industries caused by the following volatile solvents used in varnish

Acetone	Dipentene
Amyl acetate	Epiphenylin
Benzol	Toluol
Butyl cellosolve	Trichlorethylene
Carbon tetrachloride	Diethylene chloride

LACQUERS

Lacquers are essentially composed of a base of cellulose nitrate or acetate dissolved in volatile solvents. They may have added to these other resins, metallic pigments aniline dyes, plasticizers and oils

The hazards from all these substances, excepting plasticizers have been discussed under paints and varnishes. The plasticizers have not been reported to cause dermatitis although many of them cause systemic poisoning The phenyl and cresyl phosphates used as plasticizers are closely related to the ortho-tricresyl phosphate which has caused the poisoning and "Jake" paralysis among drinkers of some adulterated Jamaica ginger

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CHAPTER XXXI

DERMATOSES IN PHOTOGRAPHING, PHOTOENGRAVING, LITHOGRAPHING, PRINTING, TYPEWRITING AND HECTOGRAPHING

PHOTOGRAPHING

PHOTOGRAPHIC films are made from solutions (called "dopes") of cellulose nitrate and cellulose acetate in various solvents such as butyl alcohol, methanol, and acetone. Other chemicals such as phthalic anhydride and camphor are added to give required properties to the "dopes."

The solutions are made by mixing the chemicals in large closed vats. From the vats the solution is passed through filters and through the "casting hopper" which forms the film. The film is then passed over a series of rolls and through drying chambers in which it is "cured" and water proofed.

The men feeding the raw material into the vats to make the "dopes" come in contact with the solvents and solids, but dermatitis is rare among them. When a case of dermatitis does occur among them it is usually caused by phthalic anhydride.

The fumes of the solvents coming off the filters are irritating to the eyes of the workers and the odor of acetone, methanol, and amyl acetate used in curing and water-proofing the film is strong enough to irritate the mucous membranes of any visitor to the room where this is done, but does not seem to have any ill effects on the workers.

The film after being thus treated is rolled into large rolls and is taken to another building to be coated with "emulsion." The emulsion is made as follows in a room where only red lights are permitted.

A solution of silver nitrate is mixed in a kettle with a solution of ammonium or potassium bromide, resulting in the formation of silver bromide and ammonium nitrate. Gelatin is added to this mixture and it is allowed to cool and "ripen." Ammonia is sometimes added to the emulsion to reduce the time necessary for ripening, and if minute amounts of organic sulphur compounds such as thiocarbamides and thio-ureas are added, ripening may not be necessary.

There is little danger of argyria among workers making the emulsion because precautions are taken to prevent skin contact with the silver solutions and emulsion, nor are there any reports of bromide or iodide eruptions among these workers.

After the ripening is completed, the ammonium nitrate and excess of bromides are washed out of the gelatin and it is further purified and made into a more uniform emulsion by being forced through a perforated plate and formed into "noodles." The noodles are

then heated and melted in a pan and the film which is now ready to be coated is passed over the surface of the molten emulsion in the pan and thus picks up on one side a thin film of the emulsion It then passes through a long series of drying chambers and is then ready to be cut into suitable sizes and packed for shipment Special sensitizers can be added to the molten emulsion before it is coated on to the film or the coated film may be immersed in a solution of the sensitizer

The operations of emulsion preparation spreading drying cutting and packing are performed in rooms dimly lighted with only red lights and it would seem as if working under such conditions for eight hours each day would be a serious hazard to vision and health. But outside of a slight degree of mononucleosis and eosinophilia attributed to exposure to the silver salts amyl acetate and acetone fumes, no organic changes have been reported among such workers although some of them state that coming out into the bright sunlight after a day s work causes a temporary painful sensation in the eyes.

Photographers come in contact with many irritating chemicals in developing fixing and printing photographs yet the number of cases of dermatitis among photographers coming up before Compensation Boards is very small amounting to only 1.5 per cent of the total cases of compensated occupational dermatoses reported and of these cases 85 per cent occurred among 'blue print developers and were due to potassium bichromate

Developers are the most common causes of dermatitis among photographers and next to the bichromates used on blue prints metol (monomethyl paramino phenol sulphate) is the chief offender (Fig 60) Potassium dichromate and ammonium dichromate which are used for sensitizing gelatin and also in blue printing cause a greater percentage of dermatitis than any of the organic developers In a series of 1 000 compensated cases of occupational dermatoses occurring in Ohio in 1937 there were 13 cases in blue printing due to bichromates compared with 2 among photographers due to the organic developers.

It is said that chemically pure metol is not a skin irritant and that the dermatitis attributed to metol is really caused by traces of a poisonous compound (N.N Dimethyl paraphenylenediamine) which can be eliminated if the metol is prepared by a special process. Metol is usually made by the action of hydroquinone on methyl aniline and sulphuric acid Dermatitis may occur during its manufacture if workers are exposed to the vapors of methyl sulphate generated in this reaction Metol ($C_6H_4OH\ NH\ CH_3)_2H_2SO_4$ comes in the form of fine white needle crystals and is readily soluble in water

Amidol (Diamido phenol 1 2 4 $C_6H_3OH\ (NH_2)_2$) is made by reducing dinitrophenol with hydrochloric acid in the presence of iron filings. Dermatitis may result in this process if acid vapors are allowed to escape and the skin turns yellow and cyanosis or blue

lip results from exposure to the vapors of dinitrophenol. Diamido phenol is used as a developer and also as a fur and hair dye. It causes dermatitis in hypersensitive individuals.

Hydroquinone $C_6H_4(OH)_2$, a grayish-white crystalline solid, is a developer which has also caused dermatitis.

Hydroquinone was given in sublethal doses to black cats by Heinz Oettel, and in from six to eight weeks they had changed to a gray color.

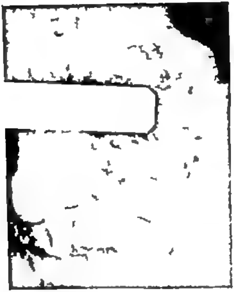


Fig. 60.—Occupational dermatitis on a photographer. Patch test positive to metol. (Case of Dr. B. M. Kesten, Vanderbilt Clinic, Columbia University, New York.)

Quinone $C_6H_4O_2$, which can be made by oxidizing hydroquinone with chromic acid, is a yellow crystalline substance having an irritating odor and is a skin irritant to hypersensitive people. Quinone dichlor diamine is said to be more irritating than quinone.

Para amino phenol $C_6H_4.OH.NH_2$ 1-4 is the basis of developers of the *Rodinal* class. It can be used as the hydrochloride $C_6H_4OH.NH_2.HCl$ or combined with NaOH. These compounds also cause dermatitis. A compound of para amino phenol with oxalic acid known as *Kodelon* is said to be less irritating.

The phenylenediamines, or diamino benzines, are used as developers in the form of the hydrochloride $C_6H_4(NH_2)_2 2HCl$. They are also used as fur and hair dyes and cause dermatitis.

Paraformaldehyde used as a photo developer has caused dermatitis on the face and hands of photographers using it.

Other photographic developers which may cause dermatitis are:

Adurol or Monochlorhydroquinone $C_6H_3Cl(OH)_2$, a grayish-white crystalline powder.

Ortol or Ortho methyl amino phenol 1 2 $C_6H_4OH.NHCH_3$.

Pyrogallol or 1 2 3 trihydroxybenzene a white crystalline powder which colors the skin a dark yellow

Pyrocatechol closely related to the hydroquinones

Sensitizers.—There are certain chemicals, mostly coal tar dyes which have the power to increase the sensitivity of photographic plates to various portions of the spectrum Some of them have been reported to have caused dermatitis by photosensitizing the skin Others of themselves cause dermatitis. They are used in only minute quantities in the photographic emulsions and cases of dermatitis among photographers have not been reported as due to their use

Eosine and erythrosine sensitizers to green and yellow have been reported as causing dermatitis by photosensitizing the skin when used in lipsticks

The principal sensitizing dyes are the cyanines and isocyanines, which are green sensitizing the di-cyanines which are red sensitizing and the pinacyanols. The dyes used in photography which have caused dermatitis are auramine aurantia chrysoidine crystal violet methyl violet malachite green and rhodamine B The latter is a photosensitizer of the skin. Other skin irritants used in photography are

Ammonium bifluoride used to remove gelatin films from glass negatives.

Ammonium sulphide used in toning and in mercurial intensification

Caustic soda used in alkaline developing solutions.

Formalin used in gelatin mixtures and pastes.

Mercuric chloride and mercuric iodide used in mercurial intensifications

Oxalic acid used as a preservative of pyro

Potassium chloroplatinate used in plate toning and platinum printing paper In addition to causing dermatitis platinum salts will irritate the mucous membranes of the respiratory tract causing sneezing and coughing

Potassium cyanide used for bromide prints and in intensification

Potassium sulphide used as a sulphur toner

Sodium carbonate used in alkaline developing baths.

Sodium hypochlorite used as a bleacher and oxidizer

The solvents such as turpentine benzene naphtha may all cause dermatitis.

Prevention.—The prevention of dermatitis among photographers consists in removing from their work those who are hypersensitive to the chemicals or in protecting them with rubber gloves and aprons and protective ointments. Patch tests with the actual solutions used in developing will reveal the hypersensitive ones.

When rubber gloves are worn they should be long enough to reach to the elbow so as to prevent fluids from entering them Impervious sleeves and aprons should also be worn If the hands

are wet with an alkaline developing solution they should be thoroughly rinsed in water or immersed in a weak solution of acetic acid. Mechanical devices such as loops may be used to place and remove films from baths and in this manner protect the skin.

Protective ointments of the water repellent type are of value to protect the face and neck from irritating vapors and fumes but are impractical on the hands where they may smear the films or pollute the solutions.

PHOTOENGRAVING AND LITHOGRAPHING

Engelhardt and Mayer examined 114 workers in Germany engaged in these occupations and reported that 10 of them had dermatitis at the time the examinations were made and that 17 others gave a history of having had dermatitis making a total of over 25 per cent of the workers affected.

In England in 1920 Overton examined 150 workers in thirty-one photoengraving and lithographing shops and found 7 per cent of them affected with dermatitis.

These authors attribute the lesions to chromic acid and its salts and to turpentine.

In Germany there occurred 202 cases of dermatitis among 9 400 engravers during the first quarter of 1930 a yearly average of 9 per cent. Most of these were eczemas due to chrome salts and zinc mordants. There is no such prevalence of occupational dermatoses among photoengravers and lithographers in the United States. Among 1,000 cases of occupational dermatoses compensated in 1937 in Ohio there were only [illegible] photogravers and lithographers and in an examination of 170 photoengravers by the authors in New York City there was found only 1 case of occupational dermatitis and that was due to ammonium bichromate.

Process.—The sensitive glass plate is made by coating one side of a pane of glass with egg albumen, then pouring over this coating a solution of collodion containing small amounts of potassium and cadmium iodides, and calcium and strontium chlorides. This solution is allowed to spread evenly and to evaporate leaving on the plate a film of cellulose nitrate containing the salts. The plate is placed in a rack and then immersed in an 0.5 per cent solution of silver nitrate in which it is allowed to remain for about three minutes after which it is lifted out. The solution is wiped from the non-sensitized side of the plate with a chamois and the excess of solution is allowed to drain off the sensitized side. The plate is then inserted into a closed photographic plate holder and is ready for use. The operations are conducted in a dark room and splashes of the solution fall on the clothes and skin of the workers leaving characteristic black spots but argyria was not noted. In some shops, a prepared emulsion is bought and poured on the plates.

The exposed plate is developed by one of several methods. In one shop the developing process consisted in pouring a solution of

ferrous oxalate and acetic acid on the plate washing it off with water then pouring on a solution of sodium cyanide to remove the excess of silver salt then washing off the cyanide solution with water and immersing the plate in a solution of copper sulphate and potassium bromide The plate is again washed with water and a solution of silver nitrate followed by sodium sulphide is poured on the plate to act as an intensifier This is again washed off and the plate is then allowed to dry The negative is then coated with a rubber cement by pouring the cement from a bottle over the negative The rubber cement used contains benzol as a solvent and there is a benzol poisoning hazard in this operation The film of rubber cement is allowed to dry and a film of collodion is poured over it and allowed to dry forming a coating of rubber and collodion over the negative The plate is then soaked in an open bath of acetic acid which softens this coating which is then lifted off the glass plate and transferred to another glass plate on which it is allowed to dry During all these operations the workers wear no gloves but despite this no cases of dermatitis were noted

A piece of zinc or copper is cut to the required size scrubbed clean and dried and then a solution of 0.5 per cent of ammonium bichromate is poured by hand from a bottle on to one side of the zinc plate allowed to spread and then dried over a gas flame If copper is used a 4 per cent solution of ammonium bichromate in water containing 25 per cent of glue is used It is this operation of pouring the bichromate solution over the plate which causes most of the dermatitis. The bichromate makes a sensitive film on the metal plate but the film is not nearly so sensitive as the emulsion on a photographic plate and must be exposed to intense light for a considerable time in order to properly register an image The negative film on the glass plate described above is placed against the sensitized surface of the metal plate and then exposed to a powerful carbon arc lamp for from one to three minutes The metal plate is then run over with an ink roller wet with etching ink and the plate washed with a solution of ammonia This leaves the ink deposited on the portion of the plate which forms the picture The plate is then dried and dusted over with a powdered natural resin called *dragon s blood* and then heated over a gas flame which melts the resin and causes a film of it to adhere to the photographed lines The film protects the image from the acid in the etching bath

For colored etchings on copper plates, the exposed plate is not at first dusted with resin but dipped into a solution of methyl violet and then heated in order to form an enamel from the glue and bicarbonate on the plate The enamel acts to protect the picture from the first dip into the etching bath Dragon s blood is applied for subsequent dips. A coating of varnish is put on the reverse side of the plate to protect it from the acid in the bath The operator placing the plate into the etching bath of strong nitric acid solution wears long rubber gloves for protection against the

acid After each dip into the etching bath the plate is coated with dragon's blood and heated and then replaced into the bath until the picture is sufficiently raised on the plate. The resin and ink are then removed from the plate by pouring on benzol followed by alcohol

When copper plates are etched a solution of perchloride of iron is used instead of nitric acid.

In cases where the picture is to be raised high above the rest of the plate the excess metal is removed by electric burrs. The workers doing this fine work wear goggles to protect the eyes from flying metal chips. When this is finished the plates are placed on wooden blocks

Burns from acid sometimes occur on etchers, but not often for the reason that etching tanks are covered and have ventilating devices to remove acid fumes.

In making engravings on copper plates for colored pictures, a separate plate is made for each color and the portion of the plate containing the color not wanted is etched away The plates are placed in a printing press which inks each one with the proper color and makes the impression in the proper place on the paper to form the picture.

Lithographing —Lithography is the art of tracing on natural or artificial stone (made of zinc or aluminum) by means of crayons or lithographic inks (which have the property of resisting the action of the etching solution) for the purpose of reproducing in quantity by printing Lithographic inks consist of mixtures of lampblack with wax soap resin tallow India rubber and turpentine Lithographic pencils are made of lampblack, tallow soap and shellac

The drawing is made on paper and the paper is dampened and then pressed on the stone thus transferring the drawing to the stone The paper is then removed. The stone is dried and then treated with gum arabic and nitric acid or chromic acid if the stone is zinc or phosphoric acid if it is aluminum The acid solution is then washed off with water and the stone is again washed with turpentine and then sponged with water The printing ink is then applied with a leather covered roller and it is ready to make imprints

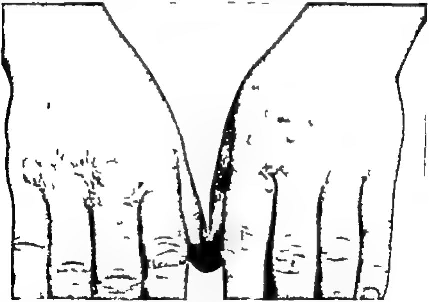
The principal skin irritants in this industry are the ammonium and potassium bichromates used to sensitize the metal plates. They cause an erythematous vesicular eruption on the hands and forearms which may go on to a chronic eczema. Hypersensitive workers may develop dermatitis from solvents and cleaners such as benzene and turpentine from the silver salts from the iodides from the bromides cyanides, developers intensifiers, glues pastes, and inks. Patch tests with *dragon's blood* performed on a number of photoengravers gave negative results. Acid burns are not as common as would be expected

The prevention of dermatitis in this occupation consists in wearing rubber gloves and having proper safety appliances on etching tanks

PRINTING TYPEWRITING AND HECTOGRAPHING

Printing —Among 1 700 tabulated ca es of compensated occupa tional dermatoses in the States of New York and Ohio there were 80 cases among printers Most of such cases occur in the smaller shops where hand composting is done but occasionally there is an outbreak among the typesetters in some of the larger mechanical printing shops and newspaper printers.

In hand composting the worker stands in front of a frame holding the type cases and picks out the required letters using the thumb and index finger of the right hand placing the letters in the stick or line holder which is held in the left hand The letters in the line are guided by the first finger and kept in place by the thumb of the left hand Tweezers and bodkins are used to make adjustments and corrections in the stick When the line is completed it is taken out of the stick and placed in a long oblong tray called a galley After the printing job is finished the type is taken out of the galley cleaned of ink and redistributed into the cases.



F G. 61 Acut occupational dermatitis in pri ter on top of an old psoriasis.

The hand of compositors often show trade stigmata in the form of callosities on the palms and at the tips of the thumb and index fingers of the right hand from handling the metallic type which is made of an alloy consisting of lead antimony and tin Erosions of the nails of the thumb and index finger also occur from the trauma of handling the metal Painful fissures of the palms and lividity of the fingertips sometimes occur in the winter due to handling the cold type. Eczema of the hands and forearms of compositors

(Fig 61) and pressmen is caused at times by the action on the skin of the various alkalis and solvents used to clean the type and presses. These consist of turpentine xylene benzol petroleum distillates and alkali cleansers such as solutions of soda ash and tri-sodium phosphate

In machine composing these hazards to the compositor are not present. In the linotype process the compositor or operator sits in front of a key board and taps the keys with the finger just as a typist does and the type is mechanically formed and set up

Pressmen working on small presses often come in contact with the printing inks. The printing inks usually consist of a homogenous mixture of lamp black, a resin such as shellac and a drying oil having the property of easily penetrating paper and quickly drying Such compositions are not irritating to normal skins. Colored printing inks however contain in addition to the resin and drying oil, finely ground mineral colors or synthetic dyes and these may cause dermatitis in hypersensitive workers coming in contact with them. Metallic colors in the form of pastes or powders composed of metals such as aluminum gold silver copper bronze white lead and zinc white finely ground with a gum or resin are also used in coloring printing

The principal dyes used in the various colored printing inks are as follows

Red Inks *Cochineal* or Carmine Colour Index No 1239 obtained from the bodies of the female insect *coccus cacti* indigenous to Mexico but found in other tropical countries.
  Redwood Colour Index No. 1252 *Caesalpinia echinata* a tree growing in Brazil and South America with the wood of a pink color but which turns red on exposure to the air
  Magenta Colour Index No. 677
  Eosine Colour Index No. 768.
  Erythrosine Colour Index No. 772
  Cyanosine Colour Index No. 778.
  Rubramine Colour Index No 806.
  Paranitraniline Colour Index No. 44

Blue Inks *Prussian Blue* Colour Index No. 1288
  Resorcin Colour Index No 907
  Aniline Colour Index No. 689
  Indigo Carmine Colour Index No 1180.

Violet Inks *Methyl Violet* Colour Index No 680.
  Crystal Violet Colour Index No 681
  Mixtures of *Carmine* and *Indigo Carmine*
  Mixtures of *Carmine* and *Prussian Blue*
  Mixtures of *Brazilian Wood* and *Potassium Dichromate*

Yellow Inks *Picric Acid* Colour Index No. 7
  Aniline Orange Colour Index No. 8.
  Persian Berries Colour Index No. 1234
  (the dried unripe berries of a shrub of the Buckthorn family)

Yellow Inks —(*Continued*)

Saffron Colour Index No 1244
(the dried petals of *Carthamus tinctorius*)

Gamboge.

Lead Chromate

Green Inks *Malachite Green*, Colour Index No 657

Iodine Green, Colour Index No 680.

Mixtures of *blue* and *yellow coloring matters*

A few of the coloring matters used in inks have caused dermatitis among hypersensitive people

Oliver reported 15 cases occurring among the readers of the colored section of a newspaper which he proved by patch tests to have been caused by the dye paranitraniline in the red ink.

Rubramine is paranitroso-dimethylaniline hydrochloride This chemical is a sensitizer and has caused dermatitis among chemists and rubber workers.

Eosine a salt of tetrabrom fluorescin is also used in lipsticks and has been reported to have caused dermatitis by photosensitizing the skin

Methyl violet crystal violet and malachite green are known to be skin irritants to certain hypersensitive people.

Picric acid is a known skin irritant among munition workers and has also caused dermatitis when used for medicinal purposes.

Typewriting and Hectographing—Dermatitis among clerical workers due to contact with carbon paper typewriter ribbon hectograph inks and indelible pencils are occasionally reported

A few cases of dermatitis among typists said to be caused by carbon paper are reported each year by Compensation Boards. Carbon paper is made as follows

The coating for the paper is prepared in large pots in which carnauba wax montan wax paraffin wax, beeswax, mineral oil castor oil stearic acid oleic acid powdered dyes, carbon black, and synthetic dyes such as methyl violet, crystal violet, milori blue victoria blue negrosine and various toners are melted and mixed The mass is then allowed to cool and solidify and is then further mixed and ground by machines into a homogenous mixture It is then coated onto the paper by a coating machine

Typewriter and hectograph inks contain similar dyes dissolved in mixtures of alcohol glycerine acetic acid gum castor and linseed oil.

Typewriter ribbons are made by running silk through ink baths

Although the clothes and skin of the workers in a typewriter ribbon and carbon paper factory which was inspected by the authors were covered with the chemicals and dyes, no cases of dermatitis were found among them However an occasional case of dermatitis in a typist attributed to typewriter ribbon is reported

The hands of printers and other workers with these dyes and colored inks are often smeared and stained with them yet dermatitis

seldom results unless strong solvents such as benzol naphtha lyes, bleaches and strong alkali abrasive soaps are used to remove them. Patch tests have often proved that the dermatitis was caused by these irritants and not by the inks or dyes.

Prevention of dermatitis in the printing trades consists in

1 Avoiding skin contact with known irritants such as the volatile solvents.

2 Wearing gloves wherever practical.

3 Avoiding the use of irritating skin cleansers.

4 Removing from the skin all traces of any cleansers by washing with water and if in spite of these measures a worker still continues to have dermatitis, he should be removed to some other job

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CHAPTER XXXII

DERMATOSES CAUSED BY RESINS AND WAXES

NATURAL RESINS

The natural resins are exudations of different species of trees (except lac which some think is the secretion of an insect, coccus lacca or tacchardia lacca, which infests the bark of the trees). They are used principally for varnishes, lacquers, adhesives, perfumery, chewing gum, and medical purposes. Those reported to cause dermatitis are:

1. *Japanese and Chinese lacquer* obtained from the exudation of the tree *Rhus vernicifera*. It contains a highly irritating chemical called "Urushiol." Dermatitis is of frequent occurrence among the gatherers of this substance and among those who handle the dried finished articles lacquered with it. The active irritant in this lacquer is the same as that in poison ivy. Pusey has reported dermatitis from walking canes coated with Japanese lacquer. O. L. Levin and E. P. Zeisler have reported dermatitis from boxes of Mah Jongg sets treated with Japanese lacquer. Indo-Chinese lacquer and Formosa lacquer are also obtained from trees of the Rhus family and can cause dermatitis.

2. *Colophony or Rosin* is the residue left behind when crude turpentine is distilled. It consists chiefly of abietic acid and is graded from the whitest (W W) to the darkest (B). Nails are sometimes coated with a mixture of rosin and tar so that they will stay firmly embedded in the wood. Workers handling such nails may develop allergic dermatitis from the rosin.

3. *Wood rosin*, similar to Colophony, is obtained from the distillation of pine stumps. Rosin is used for paper sizing, making oilcloth, mixing with rubber, making soap, in adhesive plaster, and in various other manufacturing processes. Studies made by Schwartz and Peck and by Crolnick show that it is one of the irritating ingredients in the composition of American adhesive plasters.

4. *Dammar resin* is derived from the exudation of the *Dammara Australis* and the *Dammara alba*. It is used in the manufacture of varnishes, lacquers, and adhesive plaster. Dermatitis from European adhesive plaster has been shown to be due to hypersensitivity to dammar. Gougerot and Brouet report a case of local and generalized dermatitis with systemic symptoms from adhesive plaster and positive patch tests with the dammar used in the adhesive plaster.

5. *Olibanum*, obtained from exudation of the trees of the *Uribia thaceous* order (*Boswellia carterii* and others), is used in perfumery as frankincense and as an insect repellent. It is sometimes used in adhesive plaster and causes dermatitis among those sensitive to it.

6 *Dragon's Blood*.—This is a red resin secreted by the fruits of a number of palms of the genus *Calamus draco* indigenous to Sumatra and the West Indies. It is used in the photoengraving and lithographing trades to protect the plate from the acid in the engraving bath. Although dermatitis has been attributed to dragon's blood, patch tests by the authors in several cases have showed no reaction to it, but have yielded reactions to ammonium bichromate also used by the affected patients. Dragon's blood contains benzoic acid in combination with various esters.

Other natural resins often used in varnishes and lacquers are *Elemi*, obtained from *terebinthinous* trees.

Copal, obtained from a number of fossil and recent trees such as the *Rhus copallina* of North America, the *Elaeocarpus copalifer* of the East Indies, the *Hymenaea verrucosa* of Madagascar, and the *Agathis alba* of the Philippines.

Mastic, obtained from the *Pistacia lentiscus* and *anacardiaceae*, is used in lacquer, varnish, dentistry, and chewing gum.

Sanderac, obtained from the tree *Callitus quadrivallis*.

There are other less used natural resins and many of them contain various acids, terpenes, terpene alcohols, pinene, and limonene. They may cause dermatitis.

NATURAL WAXES

Natural waxes are mixtures of esters of monohydric alcohols with fatty acids and are used principally for candles and polishes.

1. *Beeswax* is the best known variety of vegetable wax and is produced by bees from the sugar of their food. It is of complex composition depending on the species of bees who make it and on the floral origin. Although dermatitis from beeswax is rare, Schwartz and Peck report positive patch tests among persons sensitive to adhesive plaster containing it.

2. *Carnauba wax* is obtained as a yellowish-white or green exudation from the leaves, berries, and stalk of the palm *Apernicia cerifera* which grows in Brazil and southern parts of North America. The exudation is sun-dried and refined by melting and then bleaching with fuller's earth, chromic acid, potassium dichromate, or hydrogen dioxide.

3. *Chinese insect wax* is formed by the secretion of the *coccus* insect (*Coccus ceriferus*).

4. *Bayberry wax* is obtained from the bark and berries of the *Myrica cerifera*.

5. *Candelilla wax* is an excretion of the *Euphorbea antisyphilitica*, a tree of northern Mexico and southern parts of the United States.

6. *Japan wax* is obtained from the berries of the *Rhus succedanea* and several species of sumac trees growing in Japan, in East Indies, Indo-China, and Madagascar. It is used to make soap, wax matches, candles, furniture polish, and leather dressing. It has also been used as a waterproofing finish on fabrics and workers sewing the fabric

have developed allergic dermatitis. The active irritant in Japan wax is a polyhydric phenol, similar to the active irritant in poison ivy.

7. *Paraffin wax* is obtained from paraffin base oils (see Chapter on Oil Refining) and from Ozokerite by treatment with sulphuric acid. Dermatitis from pure paraffin is rare, but paraffin is often chlorinated and dermatitis sometimes occurs from chlorinated paraffin.

8. *Ceresine* is a white wax-like substance obtained from ozokerite. It is often chlorinated and used in varnishes. In this form it has caused dermatitis among weavers in cotton mills where it has been used as an ingredient in the varnish on the heddle frames, as shown by Schwartz and Pool.

9. *Montan wax* is obtained from the bitumen Thuringian lignite by extraction with a mixture of alcohol and benzene. It is used to raise the melting point of low melting waxes and to make phonographic records.

SYNTHETIC RESINS

Dermatitis is of frequent occurrence among workers making and using synthetic resins.

The number of synthetic resins manufactured and used is constantly increasing.

A resin, according to Ellis, is a solid or semi-solid complex amorphous mixture of organic substances having no definite melting point and showing no tendency to crystallize. It is characterized by such physical properties as a typical luster and a conchoidal fracture rather than by any definite chemical composition. The synthetic resins are often called plastics.

Resins are formed by (1) polymerization where a number of molecules of the same composition called monomers unite to form a larger molecule of the same composition called a polymer, and by (2) condensation where a number of molecules not necessarily of similar composition unite to form a molecule dissimilar in composition to the components, some compounds being liberated.

In homopolymerization the polymer is built by additive combination of the monomer. In copolymerization two or more molecules polymerize at the same time to form a product the properties of which differ from that of each polymer alone. Heteropolymerization is a process where additive copolymerizable substances combine with a non-polymerizable substance.

Chemicals known as catalysts are often used to affect polymerization and even to cause condensations. Catalysts are supposed to act by their presence and are not affected by the chemical reaction which they induce.

Dermatitis is seldom caused by the completely polymerized finished pure resin, or by the completely condensed "cured" finished pure resin. The monomers and low polymers, and the incompletely condensed ("cured") resin, or the uncombined components, are the

usual causes of dermatitis. The catalysts and the by-products may also be skin irritants. Many of the monomers are primary irritants as well as sensitizers. The same holds true for many of the components of resins made by condensation

The skin irritating properties of the chemicals from which the resin is made are retained in the resin as long as these chemicals are uncombined or so incompletely combined that the combination is still an irritant.

In resins formed by condensation of irritant compounds the so-called first and second stages of cure are still skin irritants. The resin varnishes glues and molding powders usually fall into these two stages of cure. The cure is completed by the application of heat after the varnishes and glues are applied and as the powder is being molded

The irritating properties of the monomers which combine to form polymers are retained in the polymerized resins as long as there is any monomer remaining in the resin or as long as there are low polymers in the resin which are skin irritants. The bi-mers are *usually less irritating than the monomers the tri-mers less than the* bi-mers etc.

Dermatitis is seldom caused by the completed condensation product, or by the completely polymerized resin. Exceptional cases may be those in which the completed resin is soluble in the secretions of the skin and if the cure or polymerization is faulty or imperfect as in the case of flash in molded resins, or insufficiently cured resin varnishes and glues.

Many of the chemical components of resins are both primary irritants and sensitizers. Examples of such are phenols aldehydes allyl alcohol styrene acrylonitrile vinyl monomers and many others.

The synthetic resins may be divided into two types according to their reaction to heat (1) thermo-setting (2) thermo-plastic

They may also be divided into two types according to their method of formation (1) resins formed by condensation (2) resins formed by polymerization.

For the purposes of this book, synthetic resins may be classified as follows

1 Phenol-formaldehyde Condensation Thermo-setting
   (a) Furfural* phenol-formaldehyde Condensation. Thermo-setting
   (b) Lignin †
   (c) Cashew nut shell oil‡—formaldehyde Condensation Thermo-setting
2 Urea-aldehyde Condensation Thermo-setting
3 A series of resins is formed by the condensation of aldehydes,

* Furfural is an aldehyde

† Lignin is a natural resin obtained from wood. It is a complex phenol reacting with aldehydes.

‡ Cashew nut shell oil consists principally of complex phenols which can react with formaldehydes.

particularly formaldehyde with a group of chemicals of which urea is the simplest. Other chemicals in this series are dicyandiamide melamine and the sulfonamides all of which will combine with aldehydes to form condensation resins. Most of these are of the thermo-setting type Many of these are used in mixtures with each other to give resins with special properties. For example we may encounter resins in which a mixture of melamine and urea is condensed with formaldehyde.

4 Ester gums Condensation. Thermo-plastic.

These are made by condensation of the acids of natural resins with glycerol or glycols.

5 Alkyd resins.

These are condensation products of glycerols or glycols with polybasic acids or anhydrides such as phthalic or maleic Some are thermo-setting and some thermo-plastic. Many of these resins are used as coating and their cure is completed by air drying

5 (a) Modified alkyds

These are combinations of alkyd resins with such chemicals as styrene vinyl chloride allyl alcohol, or other resins such as urea formaldehyde They may be made by polymerization or by condensation and are usually of the thermo-setting type.

6 Polyvinyl resins. Polymerization Thermo-plastic.

These are polymers or copolymers of vinyl chloride or acetate or acetal vinylidine chloride and vinyl carbazole may be placed in this class.

7 Acrylate and methacrylates Polymerized Thermo-plastic.

8 Polystyrene. Polymerized Thermo-plastic

9 Allyl alcohol resins and allyl mod alkyds Polymerized Thermo-setting

10 Cumarone and Indene made from tar residue Polymerized Thermo-plastic.

11 Cellulose nitrate and acetate ethyl and methyl cellulose These are derivatives of natural cellulose and are thermo-plastic.

12. Mixed types where two or more of the above types are combined

13. Polymerized hexamethylenediamine adipate (Nylon) Thermo-plastic.

14 Chlorinated resins. Thermo-plastic.

These are made by chlorinating oils, balsams and waxes.

15. Rubber hydrochloride (Pliofilm) Thermo-plastic

In addition to the above classes some non-resinous chemical products are modified by chlorination oxidation sulfurization or heat to form compounds which may be regarded as synthetic resins Examples of such compounds are the solid chlornaphthalenes chlorodiphenyls and chlorodiphenyl oxides.

The solid resins are used for making plastic panels, knobs buttons ornaments bottle caps, dishes glasses dentures wearing apparel, gears rubber compound adhesive plaster etc

The semi-solid resins are used for glues sizing adhesives wall boards, etc.

Solutions of the resins are used for lacquers varnishes floor finishes, fabric finishes hair lacquers.

The Phenol-aldehyde Resins —These may be combinations of any of the phenolic compounds and any of the aldehydes

They come in four principal forms

1 The cast resin which is finished in the factory and from which solid objects are machined

2 The molding resin usually a powder which is sold for molding objects the cure being completed in the molding operation.

3 The semi-solid incompletely combined resin used for glues and sizings.

4 The resins or their solutions in various stages of cure for use as varnishes lacquers floor paints, etc.

The cast resin is made as follows

Formaldehyde and ammonia are mixed in proper proportions in a kettle with either phenol cresol dimethyl ortho-cresol, or para tertiary-amyl phenol and heated a sufficient length of time and to the proper temperature After combination takes place the compound is drawn out of the kettle in the form of a syrup run into pans and allowed to cool and solidify This is known as first-stage resin or alpha resin The pans are then heated the resin remelted and poured into suitable molds. The molds are placed in large carriers filled with mineral oil and placed in curing ovens where they are heated and go through the so-called beta and gamma stages into the completed cast resin. After being taken out of the oven the molds are removed from the oil the resin is removed from the molds and the oil washed off with soap and water and dried It is then ready to be carved lathed or bored into whatever object is desired

During the course of these operations formaldehyde is given off and the air of the room is strong with the odor of it unless adequate forced ventilation is employed Workers in the rooms who are sensitive to formaldehyde may develop dermatitis of the face neck and arms as well as of the covered parts where there is friction such as the belt line the angle at the shoe tops and the wrists at the cuff line Irritation of the conjunctiva and respiratory tract is common.

The oil used in the curing process dissolves out of the resin some of the phenols and formaldehyde and if the oil is used over and over again without purification it contains considerable quantities of these substances as much as 2 per cent each of phenol and formaldehyde in one sample analyzed The men who handle this oil have their clothes splashed with it and at times suffer not only from oil acne and folliculitis of the legs thighs and other parts of the body touched by the oil-soaked clothing but also from dermatitis due to the irritating action of the phenol and the formaldehyde.

The eruption in these cases usually consists of diffuse erythema with scattered papules and pustules of an oil folliculitis

The girls who wash the oil off the resin with soap and water may also develop dermatitis of the hands and arms from the irritants in the oil and also from the strong soap solution with which their hands are constantly wet (Fig 62) In many factories the oil is treated with sodium hydroxide after each baking in order to neutralize the phenol and formaldehyde If this is not carefully done dermatitis may result from too much alkali in the oil

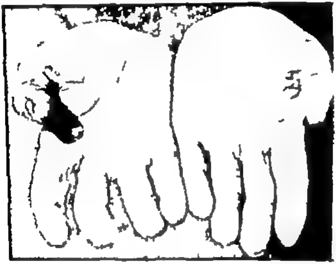

FIG. 62.—Dermatitis from cast phenol formaldehyde resin due to fore.

The skin hazards to the users of these cast resin nil since no phenol or formaldehyde is given off product

Mayers of the Division of Industrial Hygiene Department of Labor performed patch tests on 01 finished resins and obtained no reactions.

The molding resin is made up in numerous qua different proportions of phenol formaldehyde an is carried to the alpha or beta stage and then is gro blended with wood dust zinc stearate soap dye lenetetramine in a mix mill From this mill it conveyors where it is air-cooled While cooling which are ground in mills to a powder suitable workers who mix grind and pack the molding to the dust of the irritating chemicals it contain formaldehyde which it gives off the odor of rooms. (Fig 63) Dermatitis is a frequent workers in these occupations especially if the

ventilated and if the machines about which dust and fumes collect are not properly ventilated by suction ventilating hoods.

In one factory where no great care was taken to allay and prevent dust, 10 per cent of the workers were affected with dermatitis during a period of one year. Patch tests performed on 10 cases with various types of resins showed that sensitivity to hexamethylenetetramine and to formaldehyde was the cause of 80 per cent of the occupational dermatitis in this plant. Sensitivity to phenol was also found but in lesser degree than to formaldehyde and hexa. This is in accordance with Mayer's and Dolgoff's findings.

FIG. 63.—Dermatitis in molder of phenol formaldehyde resin. Hypersensitivity to formaldehyde.

The actual cause of dermatitis from exposure to hexa and formaldehyde is the same. They both finally decompose in the presence of heat and moisture into formic acid which is the real skin irritant.

The incidence of dermatitis in the manufacture of molding resins is directly related to the amount of dust in the air and the amount of formaldehyde and hexamethylenetetramine that the dust contains. Dermatitis usually occurs at the points of friction with the clothing such as the wrist, belt line, the shoe tops, and collar line. It may, however, occur on the covered part when clothing permeated with dust is worn for any length of time. The face, especially around the eyelids, is often affected. The eruption usually consists of scattered papules and vesicles on an erythematous base and is seldom disabling in character. Many workers have these eruptions for a large part of the year but continue to work. Sometimes the dermatitis disappears over the week end and returns on resuming work. New workers who are sensitive are usually affected a few

days after beginning work. If the case is a mild one and the worker continues to work, he often develops an immunity. If the dermatitis is so severe that the worker cannot continue working but must stay away from work in order to get well, immunity does not always develop. Such workers should be removed to some other occupation if they get recurrent attacks. There are also those who work for a considerable length of time without any trouble and suddenly develop a dermatitis. Such workers usually do not develop immunity but continue to have dermatitis of varying severity intermittently throughout the year as long as they work at that particular occupation.

Dermatitis sometimes occurs as a result of sensitivity to the dust of the synthetic resin used to adhere the carborundum or emery on to the paper which is used as the abrasive on emery wheels. This resin adhesive is usually a phenol-formaldehyde type of resin.

Lead poisoning has also been reported from nailers holding lead coated nails in the mouth. Workers engaged in nailing boxes have developed dermatitis from nails coated with a mixture of resin and asphalt.

Furfural Resins.—Furfural or furfuraldehyde $(CH)_3OC—COH$ is obtained by treating oat hulls and corn-cobs with sulphuric acid under steam and pressure. It is a colorless inflammable liquid which can be polymerized to form resins. It can also be combined with phenols, amines, ketones and casein to form resinous products. Most of the furfural resins are dark in color, but ivory colored resins can be made with casein mixtures. The skin hazards connected with the manufacture and use of these resins are similar to those from the other aldehyde resins.

Cashew Nut Shell Oil-formaldehyde Resin.—Cashew nut shell oil (see Plants) is obtained from the fruit of a tree belonging to the *Anacardiacea*. It consists principally of cardol and anacardol, both of which are higher phenols and closely related to the irritant principle of poison ivy and the irritant principles of other members of the same family.

There are a number of different resins made from cashew nut shell oil, but most of the dermatitis reported from these resins is among workers coming in contact with the insulating varnish (Harvel) made from it. In the experience of the author, there is no greater incidence of dermatitis from this varnish than there is from other varnishes made from other phenols and formaldehyde. The cashew nut shell oil like phenol is a primary skin irritant and a sensitizer. Patch tests with it on 15 workers elicited reactions on all of them. The reactions varied from 2+ to 4+, being most severe on new workers, and less severe on most workers who have worked for longer periods in the plant, and least severe on most of those who actually handled the oil for many years. This shows that hardening frequently occurs to the sensitizing effect of the oil but of course it does not occur to its primary irritant effect. A few workers never develop a tolerance.

Patch tests with cashew nut shell oil-formaldehyde resin in various stages of "cure" showed that its skin irritating properties decreased as the "cure" became more complete until there were no reactions to the completely cured resin.

Patch tests with the active ingredients of cashew nut shell oil (cardol and anacardol) showed that they are primary irritants and sensitizers. Cardinol, the distillate obtained from cashew nut shell oil which has been treated with sulphuric acid and partially polymerized, is a primary irritant but not as irritant as anacardol or cardol. Comparative patch tests with equivalent dilutions of anacardol and hydro-urushiol (an active irritant ingredient of poison ivy) showed that the poison ivy is a more powerful vesicant than anacardol.

Patch tests performed over skin covered with poison ivy protective ointment showed that the ointment completely protected the skin from the action of anacardol, hydro-urushiol and acetone extract of poison ivy (Lederle).

Hexamethylenetetramine, formaldehyde, and paraformaldehyde are used in making C.N.S.O.-formaldehyde resins and much of the dermatitis among workers making the resins and among those using the incompletely cured varnish is due to the formaldehyde radicle.

The prevention of dermatitis from C.N.S.O.-formaldehyde resins among the workers making and using them consists of the same measures as described under phenol-formaldehyde resins, namely, daily change of work clothes, wearing clean rubber or washable leather gloves, and impervious sleeves and aprons when working with the "uncured" resins, installation of washstands at strategic places in the plant, and instructions to the workers to wash the hands and arms with soap and water immediately after they come in contact with the C.N.S.O., hexamethylenetetramine, paraformaldehyde, and partially cured resin. Rapid desensitization with injections of increasing concentrations of C.N.S.O. may be tried on those workers who cannot develop "hardening," as shown by repeated attacks of dermatitis over a long period of employment.

The treatment of acute cases of dermatitis from C.N.S.O. consists in the application of mild wet dressings in the vesicular stage (Burow's solution 1 to 20, aqueous solution tannic acid 10 per cent) followed by mild ointments as the eruption dries and becomes scaly.

Urea-aldehyde Resins.—Urea-aldehyde resins may be made of combinations of any form of urea and any aldehyde.

The most frequently used types are made by mixing urea and formaldehyde. No heat is required, the reaction generating its own heat. A syrupy liquid results. This is mixed with bleached sulphite pulp under heat and pressure and then dried in tray driers. It is then mixed in a ball mill with pigments, zinc stearate, and a small amount of hexamethylenetetramine (about 0.5 per cent). It is finally screened and is ready for shipment. Minute amounts (fractions of 1 per cent) of other ingredients are added to different brands of urea-formaldehyde resins.

Dermatitis is less frequent among workers making urea-formaldehyde resins than among those making the phenol-formaldehyde type.

Among a group of 100 employees, there had occurred only 4 cases of dermatitis over a period of more than two years. They were all due to sensitivity to formaldehyde. Two chemists in the experimental laboratory of these plants were hypersensitive to formaldehyde and developed dermatitis when exposed to it. One of them could expose his forearm to the mouth of an open bottle of formalin and almost immediately an erythema would appear on the exposed skin. Horsfall records the case of a man who after long exposure to formaldehyde became so sensitive that he reacted to a dilution of 1 part in 8,000,000.

The process of molding powders is practically the same for all the resins. The powder is placed in a "pill machine" and pressed into proper sizes for the molds. The "pills" are issued to the molders who put them into the molds where they are subjected to heat and pressure which shapes and hardens them. During the molding process, gases are given off from the molds and the odor of formaldehyde in the room is strong, irritating the nose, throat, and eyes of those unaccustomed to it. The concentration of formaldehyde is especially strong over the molding machines and the molders often suffer from dermatitis due to these fumes. This dermatitis may affect the face, neck, and arms.

There is an excess of powder in the molds which flows out during the molding process and is only partially "cured." This is called the "flash." When the molds are opened, the "flash" is cleaned off the molds by the molders and those sensitive to the formaldehyde or phenol in the imperfectly "cured" dust develop dermatitis on the hands or forearms. Girls are usually employed to file "flash" off molded objects (finishing and inspecting) and dermatitis is quite frequent among them. The forearms are usually affected by the dust of the imperfectly cured "flash," especially from the phenol-formaldehyde resins, although it may occur from the urea-formaldehyde resins.

The worker who handles the molding powder in order to place it in the "pill" machine and issue it to the molders is also exposed to a skin hazard from the materials which he handles. The dermatitis of the molder, however, usually occurs on the wrists and the palms. The dermatitis of the palms manifests itself in the form of a chronic fissured eczema, whereas that on the wrists is of the erythematous vesicular type.

That hexamethylenetetramine is a large causative factor in dermatitis caused by these resins is indicated by the fact that most of the cases have occurred among workers handling the phenol-formaldehyde resins which contain many times more of the hexamethylenetetramine than do the urea-formaldehyde resins. Hexa, formerly used in the rubber industry as an accelerator, has caused many cases of dermatitis but has now been almost entirely displaced

by other accelerators. It is a necessary ingredient of certain phenol-formaldehyde molding powders because it furnishes the necessary amount of formaldehyde and ammonia for the resin to go through the gamma stage or to completion in the molding process. In the urea-formaldehyde resin hexa acts as a stabilizer to prevent the resin from hardening before it is molded. Less than 1 per cent of it is used in the resin.

Dermatitis among the users of molded phenol-formaldehyde and urea-formaldehyde resins is rare, but may occur if any of the "flash" is left on the object or if the molding process is not completed and the hexa is not all combined. Theoretically all the hexamethylenetetramine is combined in the completed resin, but practically in some imperfectly cured pieces or in pieces where too much hexa has been used in the molding compound, there may be a sufficient amount left in the finished object to cause dermatitis among hypersensitive users. The same thing may be true of the phenol content.

Blumenthal and *Jaffe* described 7 cases who had weeping eczema on the uncovered portions of the body, especially the hands. All of these patients worked with "bakelite" * varnish. Patch tests showed that the "bakelite" in the varnish was the cause of the eczema and that all who developed eczema were hypersensitive to phenol. The composition of the "bakelite" varnish was not given.

Melamine Resins.—The melamine resins are made by polymerizing dicyandiamine to form melamine, a white powder which can be combined with formaldehyde or with urea-formaldehyde to form a resin. Dermatitis may occur in its manufacture chiefly due to formaldehyde as described under urea-formaldehyde resins.

The melamine resins can be used for the same purpose as the urea-formaldehyde resins. Dermatitis from melamine resin glues has been reported in the manufacture of plywood and laminated products.

In a plant where fabrics were laminated with a melamine resin and then molded into airplane engine exhausts and then heat cured, dermatitis occurred among the workers who handled the uncured moist laminated fabrics as they came out of the liquid resin dip, as they were being cut to shape, as they were molded onto forms and as they were trimmed and finished after being cured.

Patch tests with the liquid resin and with the uncured laminated fabric gave severe reactions on those affected. Patch tests with the cured laminated fabric gave milder reactions. This showed that the "cure" was not complete. This particular melamine resin contained 10 per cent by weight of resorcinol.

Sulphonamide Formaldehyde Resins.—The sulphonamide-aldehyde resins are made by combining p-sulphonamide (a by product in the manufacture of saccharin from toluene) with formaldehyde. They are soluble in alcohol and acetone and are used in varnishes and lacquers. Because they are mixable with solutions of cellulose nitrate and acetate, the sulphonamide-formaldehyde resins have

* Bakelite is the trade name of a variety of synthetic resins.

been used as adhesives and plasticizers in nail lacquers. Many cases of dermatitis from nail lacquer have been traced to the sulphonamide-formaldehyde resin contained therein

Ester Gums.—Ester gums are usually glyceryl methyl, and ethyl esters of abietic acid They may be combinations of any of the natural resins with glycerol ethylene glycols, other polyhydric alcohols phenols naphthols, and drying oils.

Ester gums are used in paints, enamels, lacquers varnishes fabric finishes adhesive plaster paper sizing and even as emulsifying and wetting agents (Rosin soaps.)

The ester gums are made in closed kettles and no cases of dermatitis were observed among the workers but an outbreak of dermatitis occurred among people wearing fabrics finished with a preparation of an ester gum and the ester gum was proved to be the actual irritant.

Alkyd Resins.—Alkyd resins are combinations of polybasic acids and polyhydric alcohols. They are usually combinations of phthalic anhydride or maleic anhydride with glycerol ethylene or propylene glycols mannitol or sorbitol. The polybasic acids may also be combined with drying oils and natural resins They are used to protect metal surfaces such as automobile lacquers for printing inks laminating glass or wood or paper abrasive wheel bindings etc.

The manufacturing process consists of cooking the chemicals in closed kettles. An occasional case of dermatitis occurs from phthalic or maleic anhydride and from solvents used to place the finished resins into lacquer or varnish form Phthalic acid is a sensitizer and maleic acid is a primary irritant and sensitizer

Dermatitis occurs in the use of these resins as adhesive for laminating wood and fabrics

An outbreak of dermatitis from hair lacquer was traced to the use of a resin formed from maleic anhydride and rosin which was used as a substitute for shellac, the usual ingredient.

Modified Alkyd Resin.—The alkyd resins are frequently modified by combination with other resin forming chemicals. Combinations with melamine-formaldehyde resins have been reported to cause dermatitis among workers handling the partially cured resin. Combinations of alkyd resins with glycols and styrene or vinyl chloride or allyl alcohol are extensively used for laminating purposes. These combinations form liquid or soft paste-like monomers which are primary skin irritants and have caused extensive outbreaks of dermatitis among workers handling them. The further polymerization proceeds the less the irritant powers of the resin until the completely cured resin is innocuous. Imperfectly cured pieces however or "flash" may cause dermatitis.

In a factory where Radar casings were being made from a modified alkyd resin and fiberglas a large number of cases of dermatitis occurred The resin is made by condensing styrene with maleic acid and diethylene glycol to form the monomer The monomer is a straw colored paste-like substance with a pungent irritant suf

focating odor which will soon cause irritation of the eyes and nose and throat If permitted to stay on the skin for a few minutes it will cause stinging and erythema, and if it stays on for an hour or two it will cause blisters. This substance is not only a primary irritant, but also a sensitizer so that many who develop a primary irritation also become sensitized and develop dermatitis from exposures which are so slight that they would have had but little effect before sensitization

The manufacturing process in this factory was as follows

A roll of fiberglas is degummed and then passed through the resin to which benzoyl peroxide has been added (1.5 per cent) The sheet of fiberglas is then passed through a roll to force the resin into it. The sheet is cut into suitable lengths and placed on a form A sufficient number of sheets are smoothed down on the mold by pressure of the hands The top of the mold is then put on (a piece of cellophane is interposed between the sheets and the top of the mold) and the mold is placed in the curing cylinder where the heat is applied When the cured mold is taken out of the cylinder the resin sheet is trimmed to size the flash being removed All these operations entail handling the resin.

Dermatitis even occurs among those handling the fiberglas. This is due to mechanical irritation of the glass fiber and the rubbing into the skin of the resin binder on the glass fiber Workers handling the glass fiber should wear gloves and sleeves

The following preventive recommendations were made

1 Those girls who handle the resin-impregnated sheets should also wear gloves (the fingers may be cut so as to enable easier manipulation) Long sleeved smocks should also be worn The gloves (preferably washable leather) and the smocks should be cleaned at least once a day Those whose jobs require handling the resin paste should wear long rubber gauntlets

2. Those employed at places or occupations where there is a strong concentration of fumes should be provided with a protective ointment for the face and neck of the type which leaves a dry adherent water-repellent coat on the skin to shield it from fumes. This ointment may also be applied to uncovered parts of the fingers.

3 Well placed ventilators to draw fumes away from the workers.

4 The use of broad spatulas with handles to smooth the resin impregnated fiberglas down over the molds. This would eliminate much of the contact with the resin

5. Placing washstands close to the workers and instructing them to wash the resin from the hands and fingers at frequent intervals.

6 Instructing workers not to touch face and neck with resin soiled hands.

Polyvinyl Resins —These are thermo-plastic resins made by polymerization of vinyl acetate or vinyl chloride or copolymerization of the two Polyvinyl alcohol resins and combinations such as butaryl acetal of polyvinyl alcohol and vinyl carbazole may also be included in this class.

VINYL PLASTICS

Polyvinyl chloride (Flamenol, Koroseal, Korogel, Koroseal, Vinylite Q)
Polyvinyl acetate (P V Acetate Vinylite A)
Polyvinyl chloride with vinyl acetate (Elastl-Glass, Resovin, Tygon Vinylite V Vinyseal, Vinyon)
Polyvinylidene chloride (Apla, Mills Plastic, Saran Vec, Velon)
Polyvinyl alcohol (PVA Solvan)
Polyvinyl formal (Formex, Formvar)
Polyvinyl acetal (Alvar)
Polyvinyl butyral (Butacite, Butvar Flexseal, Heydenite, Horco X, Saflex, Vinal, Vinylite X)
Polyvinyl benzal (Benvar)
Polyvinyl crotonal (Crotvar)
Poly-N vinyl carbazole (Luvican)

Vinyl resins are used for wearing apparel lamination of fabrics, electric insulators, lining of tin cans, dentures molding purposes, phonograph records and many other purposes. No cases of dermatitis have been reported in the manufacture of vinyl acetate or vinyl chloride and their polymers, but dermatitis has occurred from wearing wrist watch straps garters and suspenders made of the polyvinyl copolymers. The actual irritants in the wearing apparel were found to be the plasticizers and stabilizers contained in the resin (dibutyl tin maleate and dibutyl sebacate) Workers engaged in coating fabrics with the copolymer of vinyl chloride and vinyl acetate were affected with dermatitis which was found to be due to a by-product formed in the recovered acetone solvent during the recovery process. The chemical formed was bi-acetyl When the bi-acetyl was removed the outbreak of dermatitis ceased

Vinyl carbazole is used as an electrical insulator and the monomer a white powder is a strong sensitizer It causes considerable dermatitis among those in contact with it. The polymer formed by heating the monomer is also a sensitizer but not as strong as the monomer

Butaryl acetal of polyvinyl alcohol is made from polyvinyl acetate which is hydrolized to polyvinyl alcohol and this is condensed with butaryl aldehyde The resin is plasticized and made into a water-white sheet used in making shatterproof glass. The sheets of the resin are powdered with sodium bicarbonate so as to prevent them from adhering to each other in shipment Dermatitis has occurred among workers applying the sodium bicarbonate and among workers in the safety glass factory who separate the sheets. The dermatitis is caused by the sodium bicarbonate being converted to sodium carbonate which is the actual irritant Workers exposed to the sodium carbonate sometimes have their hair bleached to a blond color Workers handling sheets of resin treated with sodium bicarbonate should wear impervious gloves, sleeves aprons, and caps. They should be furnished with clean work clothes daily and take showers before going home from work.

The vinyl radical can be combined with a glycerol and dibasic acid resin to form modified alkyd monomers which polymerize

(with the catalytic aid of an organic peroxide and heat) into thermo-hardened resins (See Alkyd Resins.)

Acrylic and Methacrylic Acid Resins.—These acids are colorless liquids which polymerize and the polymerized ethyl and methyl esters form resins which can be used as glues for adhesion to glass. They can be polymerized to form transparent sheets used for windows, lenses and transparent plastics. The monomer can be used as the plasticizer

Methyl methacrylate is polymerized by the action of heat in the presence of benzoyl peroxide to form a clear transparent resin used for many purposes (Lucite and Plexiglass) Dermatitis has occurred among dental technicians molding it to make dentures The actual irritant is said to be the monomer a water white liquid used to plasticize the resin mass The catalyst benzoyl peroxide may also cause dermatitis

The prevention of dermatitis among dental technicians from the resins used for making dentures consists in wearing rubber gloves and impervious sleeves and aprons

Polystyrene Resins.—Styrene (C_6H_5—$CH=CH_2$) is a colorless liquid boiling point 143° C It is a fat solvent and primary skin irritant It can be polymerized into a hard colorless thermo-plastic resin by dissolving it in ethyl benzene and heating in the presence of a catalyst (benzoyl peroxide)

The polystyrene resins are used for lacquers molding insulators laminating glass, etc.

The copolymers of styrene and butadiene form the synthetic rubber Buna S and the copolymer with acrylonitrile forms the synthetic rubber Buna N Dermatitis occurs in the manufacture of styrene and in the manufacture of synthetic rubber from styrene

Styrene is also used to modify the alkyd resins. The monomer made by condensation with glycerols and a dibasic acid is polymerized into a thermo-hardened polymer by means of a catalyst (organic peroxide) The monomer is a primary skin irritant (See Modified Alkyd Resins)

Allyl Resins.—These are among the newest of resin They are made from allyl alcohol a water white liquid of low boiling point It is soluble in water alcohol and ether It volatilizes readily and gives off pungent vapors which irritate the mucous membranes and the skin When allyl alcohol touches the skin the effect is not felt for an hour or more when an ache in the part begins and continues The blister appears about twenty-four hours later

Allyl alcohol is combined with di-glycochlorformate to form the liquid monomers These monomers are semi-solid or more or less thick viscid clear liquids which are primary skin irritants and sensitizers. In making di-glycochlorformate phosgene is reacted with diethylene glycol and there is a hazard of phosgene exposure The di-glycochlorformate is a primary skin irritant Workers with allyl alcohol and di-glycochlorformate should wear impervious sleeves aprons and gloves as well as goggles.

The monomers can be polymerized into solids by adding benzoyl peroxide and heating. The completely polymerized resins are thermo-setting. No pressure and but little heat is required to polymerize the monomers and form laminated materials by the use of these resins.

Considerable dermatitis has occurred among workers making and using allyl resins. Although the monomers are primary irritants, older workers often continue work without much trouble both because of carefulness in not permitting the resin to stay on their skin for any length of time and because they become "hardened" to the sensitizing effect of the resins. The completely polymerized resins are inert. The monomers give off allyl alcohol which is the actual irritant.

The allyl resins are used for laminating fiberglas to make gasoline tank linings, to make suitcases, etc.

Cumaron Resins.—Cumaron resin is made from the crude coal tar distillate which comes off between 150° and 200° C. This is redistilled to remove impurities and a sharply fractionated naphtha is obtained. This is treated with sulphuric acid to remove readily polymerizable hydrocarbons and to dry the naphtha. The tar and sludge are allowed to settle out and the remaining oil is pumped into a tank and treated with caustic soda. The oil is then distilled, the naphtha and naphthalene removed, leaving a heavy oil which boils between 320° and 330° C. and cumaron resin.

The process is almost totally enclosed and there are no special skin hazards with the exception of acid and alkali burns.

There are various grades of cumaron resin, the darker ones being used in varnishes, adhesives, rubber, paint, printing inks, and water proofing, while the purest and whitest are sometimes used in chewing gum. The darker grades of cumaron resin may contain sulphonic acids and tar acids if they are not carefully prepared and it is probably these acids which cause dermatitis. The melanosis and photosensitivity described under coal tar is sometimes seen among workers who make cumaron resin where the process is not totally enclosed.

Dermatitis occurred from the darker cumaron resins in a varnish which was used on heddle frames in a cotton mill. The forearms of the weavers were struck continuously by the moving heddle frames coated with this varnish and some of the workers developed dermatitis on the forearms at the points of contact with the heddle frames. Patch tests showed that they were sensitive to chlorinated ceresin and cumaron resin in the varnish.

Cellulose Resins.—Celluloid or Pyroxylin are trade names for a material made of scraps of cellulose nitrate or cellulose acetate which are mixed with camphor and various plasticizers such as tricresyl phosphate, dibutyl phthalate, dimethyl phthalate, and solvents such as alcohol, acetone, ethyl acetate, amyl acetate, etc. Dermatitis is rare but has been reported among workers who manufacture these products.

Pliofilm —Pliofilm is the trade name of rubber hydrochloride. Dermatitis occurs in its manufacture and may be due to hydrochloric acid alkalis, solvents or the chemical used as a stabilizer a compound of resorcinol morpholine and formaldehyde An outbreak of dermatitis among workers making airplane engine covers out of pliofilm was shown to be caused by the stabilizer The heat of the iron used to heat-seal the covers caused fumes of the stabilizer to be given off and it caused dermatitis.

Nylon —Nylon is the trade name for polymerized hexamethylenediamine adipate a long chain polymer with high molecular weight The monomer comes as a water white aqueous solution to which titanium oxide is added and the water evaporated and then with heat and pressure form the polymer After adding a stabilizer to the polymer it is extruded in the form of a wide ribbon This is cut up into chips which are melted and the thick liquid is forced through spinnerettes to make the thread The thread is twisted stretched moistened with oil covered with a size and spooled. In a factory where these operations were conducted no cases of occupational dermatitis were found. Whatever dermatitis may result from wearing nylon fabrics would be caused by dyes, or finishes on the fabric.

LAMINATING FABRICS WITH RESINS

The fabric is usually passed through a solution or liquid phase of the A stage resin which is forced into the fabric It is then partially cured by heating and then cut into the desired shapes and sizes The pieces are then placed one on top of the other until the desired thickness is attained The thick layers are then formed into the desired shape by fitting over forms and trimming These are then placed into molds and the cure completed by heat and pressure Any flash or irregularities are then trimmed off Dermatitis occurs frequently among those handling or in contact with the partially cured resin-impregnated fabrics. It usually affects the hands forearms neck and face It may be merely an erythema, or erythema with papules vesicles and crusts

Protective measures consist in the wearing of impervious sleeves aprons and fingerless gloves as well as a protective ointment either of the lanolin-castor oil (Type 3) or of the dry type (Type 4) (See Chapter VIII Protective Ointments.)

Dermatitis also occurs among those handling the finished objects Patch tests with the finished object were positive in those affected This shows that the resin is not completely cured or polymerized and should receive a longer final "cure

Some of the monomers of the thermo-setting polymerized resins are primary skin irritants. Especially is this true of a number of the modified alkyd resins used for laminating fabrics glass fibers and wood veneers. The modified alkyd resins containing styrene or allyl alcohol combined with an alkyd resin such as combinations of glycols and phthalic or maleic anhydride have been found to be

particularly irritating in the partially polymerized stage In one factory using these types of resins for laminated glass fabrics there was a labor turnover of 000 per cent among 85 workers in one year There is no hardening to the primary irritant action of these monomers.

Modified alkyd resins of this type are sometimes miscalled styrene resins or allyl resins depending on the modifying molecule

RESIN GLUES

An increased use of glues is entailed in the manufacture of modern laminated products. With this there has been an increase in occupational dermatitis.

The resin glues are usually incompletely polymerized or incompletely cured resins, or solutions of resins all of which are either primary skin irritants or sensitizers. In one plywood factory employing about 800 workers 000 cases of dermatitis occurred in the first six months of operation In another factory making tool handles from laminated glass and employing 100 workers, there was a labor turnover of 40 per month during the first six months of operation

The resin glues are used in the manufacture of plywood fiber board laminated asbestos glass fabric tool handles, coatings for fabric and paper making rocket tubes and many other purposes.

Composition of Glues —Glue compositions vary widely They can be roughly classified as (1) protein glues (2) natural resin glues (3) synthetic resin glues (4) combinations of the foregoing

Catalysts may be used in glues containing the synthetic resins

The protein glues can be made from gelatin, hides bone cartilage casein isinglass (air bladder of the fish) fish heads (cod haddock hake) and vegetable protein (soya bean)

The natural resin glues may be made from dextrin gum arabic, acacia shellac, copal dammar rosin etc To any of these may be added such chemicals as sodium silicate sodium hydroxide sodium fluoride zinc chloride and copper salts. It is evident that a glue the name of which may lead one to think that it is quite harmless (gelatin glue casein glue) may actually contain powerful primary skin irritants.

The following synthetic resins, either alone or in combination with each other or with natural resins may be used as liquid cold glues, thermal-setting glues or molding powder glues cumarone polyvinyl esters, ethyl esters, methyl esters cellulose esters cellulose nitrate alkyd urea-formaldehyde phenol-formaldehyde melamine formaldehyde melamine-urea, allyl and styrene

In the manufacture of these synthetic glues, catalysts are often added For this purpose mineral acids (HCl or H_2SO_4) alkalis ($NaOH$ KOH CaO NH_4OH etc.) zinc oxide potassium cyanide hydrazines amines hydrochloride sodium ethyl sulfate and organic peroxides The completely polymerized or cured resins rarely cause

dermatitis but completely polymerized resins can seldom be used as glues. The incompletely polymerized or partially cured resins are the ones most used as adhesives and these contain the incompletely combined irritant chemicals which can and do cause dermatitis. The addition of the catalysts, many of which are themselves primary irritants, increases the skin irritant properties of resin glues.

The urea-formaldehyde, the phenol-formaldehyde, allyl modified alkyds and melamine-formaldehyde resin adhesives are the ones most frequently reported as causes of dermatitis. (Fig. 64.)

FIG. 64.—Dermatitis from resin glues.

To determine the irritating chemical radical causing the dermatitis, the actual composition of the resin and the stage of polymerization should be known before patch tests can be performed intelligently. This information must be obtained from the manufacturers, as chemical analysis often fails in this respect.

In studies of dermatitis from resin molding powders it was found that formaldehyde was the chief irritant in phenol-formaldehyde resins, being responsible for about four fifths of the cases. Hexamethylenetetramine, which is present in many of the molding powders to supply the additional formaldehyde needed to complete the cure in the mold, is not present in the glues. But, since formaldehyde is present in the urea and phenol-formaldehyde glues, the absence of hexamethylenetetramine does not deprive them of their skin irritative properties. The presence of phenols and formaldehyde in the glues can often be detected by the odor.

They are used in powder form, paste form, in solution, and as cold glues or thermal-setting glues (with the addition of pressure).

These glues are primary skin irritants if they come in contact with the skin in sufficient concentration. That these glues are also sensitizers is proved by the fact that the workers having dermatitis react more rapidly to patch tests than do the controls, as well as by the fact that about 50 per cent of the affected workers, if they are permitted to work while undergoing treatment, develop a tolerance to limited contact with the glues containing comparatively weak concentrations of the irritant chemicals.

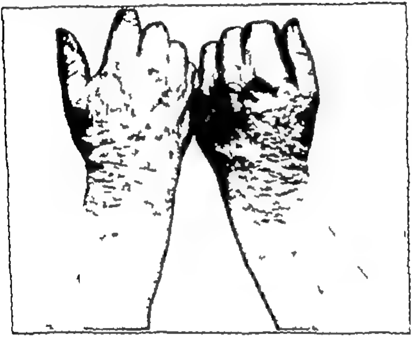

FIG. 65.—Dermatitis from resin glue.

In making plywood for planes and gliders, those who apply the cold liquid glues to the edges of the sheets of wood and those who apply the glue tapes (Tego) to the surface of the panels to cover defects are the ones most likely to be affected with dermatitis. The parts most often affected are the palms where they contact glue-soiled brush handles and spatulas, the dorsum of the hands (Fig. 65) from glue-soiled washing solutions and glue-soaked sponges, and the forearms which are touched with glue-soiled fingers and tools. Those who work without stockings while shaping the panels in the molds often develop dermatitis on the legs where the glue touches the skin.

In some cases dermatitis begins as early as the third day after exposure (the primary irritant effect of the glue) while others may be exposed several weeks before dermatitis occurs. No doubt the degree of exposure to the glues and the personal cleanliness of the

worker are the main factors determining the time of onset of dermatitis

Those working on the presses which heat and press together the sheets causing them to adhere and form plywood are only occasionally affected The workers are subjected mainly to the fumes of formaldehyde coming off the presses and only occasionally to contact with the uncured glue

In factories where plywood propellers and other rigid parts are made the contact is somewhat different Here the pieces of veneer are impregnated with liquid resin glue by dipping them into a vat and then placing them in a pressure chamber The workers at this operation are exposed to strong fumes of formaldehyde and to splashes of liquid Unless properly protected these men will develop dermatitis conjunctivitis and irritation of the respiratory tract Those engaged in mixing the glues are similarly exposed Workers who machine sandpaper and polish plywood are exposed to wood and resin dusts Some of the plywood is machined before the resin glue is completely cured and at such operations there is more dermatitis than at operations where the completely cured resin dust is encountered

In factories where glass cloth is made into tool handles and translucent partitions workers thought the glass fabric was the cause of the dermatitis but patch tests showed that the condition was caused by phenol-formaldehyde molding powder which is spread on the fabric before it is placed in the hot pressure molds. The operation of placing the molding resin powder on the cloth should be performed in such a manner that the resin powder does not come in contact with the worker

The catalysts used in these factories were ammonium chloride ammonium sulfate oxalic acid ester hypophosphorous acid ester and benzoyl peroxide lauroyl peroxide para tertiary butyl benzoate

The principles of treatment of dermatitis caused by the glues are the same as for any other form of contact dermatitis. In the acute stages where there is edema vesicles and oozing only soothing wet dressings should be used such as boric acid solution Burow s solution and tannic acid solution 3 to 5 per cent this last on parts other than the face or neck. In the later stages when the eruption begins to dry and crust the use of mild fatty base ointments such as boric acid ointment calamine ointment or zinc oxide ointment should be used The use of phenols for antipruritic purposes should be avoided because they may increase the dermatitis. If complications such as infection set in special treatment may be required Workers with mild cases should be given protective clothing and should be treated on the job in order to give them the chance to become hardened (if the dermatitis is caused by allergy) and to learn how to protect themselves (if it is due to primary irritation)

To prevent dermatitis among workers with resin glues, the management should first of all provide suitable exhausts to draw away from the workers all irritant dusts or fumes coming off the opera

tions The management should provide daily clean coveralls for all workers exposed to irritant glues dusts and fumes.

Workers who apply the glues to the veneer should be provided with impervious gloves made either of washable leather or fabric-lined rubber and sleeves and aprons of impervious materials. The sleeves should fasten over the gloves at the wrist to prevent irritants from falling into the gloves.

Facilities for washing the hands with soap and running water should be installed at strategic places so that the workers can frequently wash glue from the gloves and skin The brushes and sponges used for glueing should be washed or changed about every two hours and workers should be cautioned against touching the face and other parts of the body with glue-soiled fingers gloves or tools

Sufficient shower baths should be provided for workers and they should be compelled to take showers after work. Sufficient time should be allowed for this and the workers should be paid for the time

Protective ointments or applications are not necessary if these precautions are observed but if they are used they should be furnished by the management and should be used in addition to all of the other preventive measures The type of applications best suited to prevent glues from touching the skin are those of the water-insoluble invisible glove type or of the water-repellent fatty type

SYNTHETIC WAXES

The principal synthetic waxes manufactured in this country are the chloronaphthalenes and the chlorodiphenyls. They are both used for practically the same purpose as electric insulators on condensers, wires in transformers, in paints in varnishes and in lacquers. (Fig 66.)

An acne-like condition of the skin was described during the World War among workers who made gas-proof clothing and masks in which processes the chlorinated naphthalenes were used to make the fabrics gas-proof The Germans called this disease "Perna Krankheit It has since been described by Nicholas and Pillant by Milian and Perin and by many others in Europe. Although chlorinated naphthalenes have been manufactured in the United States since 1912 and cases of dermatitis and acne have occurred among the workers handling them since that time the first cases recorded in the United States were in 1931 when 4 workers with the chlorinated naphthalenes applied to the New York State Labor Department for compensation. Schwartz reported that nearly all the workers examined in the United States who were exposed to the fumes of the chlorinated naphthalenes and diphenyls and chlorodiphenyl oxides for any length of time were found to have a comedone acne-like condition of the skin. Jones and Alden reported a similar condition among workers with the chlorinated diphenyls.

worker are the main factors determining the time of onset of dermatitis

Those working on the presses which heat and press together the sheets causing them to adhere and form plywood are only occasionally affected The workers are subjected mainly to the fumes of formaldehyde coming off the presses and only occasionally to contact with the uncured glue

In factories where plywood propellers and other rigid parts are made the contact is somewhat different. Here the pieces of veneer are impregnated with liquid resin glue by dipping them into a vat and then placing them in a pressure chamber The workers at this operation are exposed to strong fumes of formaldehyde and to splashes of liquid Unless properly protected these men will develop dermatitis conjunctivitis and irritation of the respiratory tract Those engaged in mixing the glues are similarly exposed Workers who machine sandpaper and polish plywood are exposed to wood and resin dusts Some of the plywood is machined before the resin glue is completely cured and at such operations there is more dermatitis than at operations where the completely cured resin dust is encountered

In factories where glass cloth is made into tool handles and translucent partitions workers thought the glass fabric was the cause of the dermatitis, but patch tests showed that the condition was caused by phenol-formaldehyde molding powder which is spread on the fabric before it is placed in the hot pressure molds. The operation of placing the molding resin powder on the cloth should be performed in such a manner that the resin powder does not come in contact with the worker

The catalysts used in these factories were ammonium chloride ammonium sulfate oxalic acid ester hypophosphorous acid ester and benzoyl peroxide lauroyl peroxide para tertiary butyl benzoate

The principles of treatment of dermatitis caused by the glues are the same as for any other form of contact dermatitis. In the acute stages where there is edema, vesicles and oozing only soothing wet dressings should be used such as boric acid solution Burow's solution and tannic acid solution 3 to 5 per cent this last on parts other than the face or neck In the later stages when the eruption begins to dry and crust the use of mild fatty base ointments such as boric acid ointment calamine ointment, or zinc oxide ointment should be used. The use of phenols for antipruritic purposes should be avoided because they may increase the dermatitis. If complications such as infection set in special treatment may be required Workers with mild cases should be given protective clothing and should be treated on the job in order to give them the chance to become hardened (if the dermatitis is caused by allergy) and to learn how to protect themselves (if it is due to primary irritation)

To prevent dermatitis among workers with resin glues the management should first of all provide suitable exhausts to draw away from the workers all irritant dusts or fumes coming off the opera

The chlorodiphenyls are used in conjunction with the chloronaphthalenes as insulators for electric wires and on condensers. A certain percentage of chlorodiphenyl are used to make some of the chloronaphthalene products.

In the manufacture of diphenyl the benzol not used in the reaction is recovered and the workers are exposed to benzol as well as to the fumes of diphenyl The workers who handle the hot chlorodiphenyls and chlorinate the diphenyl especially the operation in which the crude chlorodiphenyls are redistilled to remove impurities are affected with an acne comedone condition of the skin similar to that of workers who handle the chloronaphthalenes or are exposed

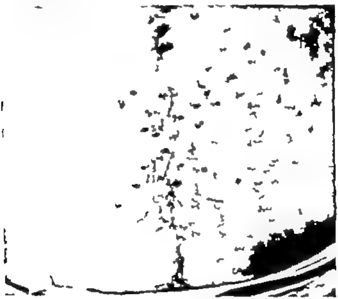

Fig 67 — Acne due to mixture of chloronaphthalenes and chlorodiphenyls.

to the fumes. The fumes of both these compounds as well as prolonged contact with the cold substances first cause comedones on the parts exposed to their action. (Fig 67) When they penetrate or soil the clothing they cause lesions on the covered parts the shoulders, arms, abdomen, back, thighs, legs, and even the penis. The lesions begin as small comedones or as blind cysts and develop into hard cyst-like elevations, some of which may suppurate. The lesions occur in the follicles, resemble the comedones and pustules of acne vulgaris. They do not as a rule suppurate but remain as straw colored elevations or cysts Histologically they can be distinguished from acne vulgaris. (See Occupational Acne)

In factories where these substances are used to insulate wires and condensers (Fig 68) all the workers exposed to the fumes from the coating bath will in time develop the skin lesions. A considerable percentage of those handling the cold insulated wire in such opera-

tions as reeling and covering the insulation with fabric also develop the lesions, especially on the parts touched by the compounds on the wire. Electricians stripping wires insulated with these compounds also develop chloracne.

Those workers who have an excess of sebaceous secretions are especially affected, but practically all the workers exposed for six months or longer develop these skin lesions. They are chronic and require long periods of treatment. Cases of this condition have occurred among the families of workers with these compounds and have been caused by contact with soiled work clothes. Wives who handle and wash the soiled work clothes and children who play with their father while he has on the soiled work clothes have also become affected.

FIG. 68.—Chloracne from coating wires with solid chloronaphthalenes.

In addition to these skin lesions, systemic poisoning has occurred among exposed workers who complained of digestive disturbances, burning of the eyes, impotence, and hematuria. Hematuria developed among a number of men making amino-diphenyls. Cases of death from yellow atrophy of the liver occurred among workers exposed to mixtures of chloronaphthalenes, chlorodiphenyls, and their solvents. Patch tests performed with these synthetic waxes yielded negative results when left on for seventy-two hours. Chlor diphenyl oxide is a soft waxy substance used as a di-electric lubricant. It causes acne-like lesions similar to those caused by the chloronaphthalenes and chlorodiphenyls.

Individual hypersensitivity does not play a part in the etiology

of this industrial skin disease. The skin lesions probably result from the plugging of the follicles of the skin with the waxes as the fumes solidify on the skin or as the friction incidental to handling them rubs into the skin the particles of the cold wax. An application of the cold wax to the skin for a period of months in the form of a patch test is said to have resulted in the production of comedones in one person. Although the vapors of these substances are not decomposed and contain no chlorine or hydrochloric acid they are keratogenetic causing proliferation of the epithelium of the glands The lesions are really cysts of keratin.

Some of the lesions go on to suppuration while others remain hard yellowish cysts. The treatment for these is evacuation either by manual expression or incision. X-ray is of doubtful value.

Some Unusual Occurrences of Chloracne.—An outbreak of chloracne occurred among foundry workers marking hot steel castings with crayon containing chlorinated naphthalene as a pigment binder The high temperature of the castings volatilized the chlorinated naphthalene and caused the chloracne on the exposed parts of the workers.

In a plant making hydrochloric acid an outbreak of chloracne occurred because chlorohydrocarbons were formed in the manufacturing process. In order to increase the output of hydrochloric acid the salt briquettes were mixed with soft coal. The heat applied to the briquettes formed coal tar from the soft coal which when acted upon by the hydrochloric acid formed chlorohydrocarbons These deposited in the tubes carrying away the acid and also came away in exhaust gases. Workers clearing the tubes and retorts came in contact with the chlorohydrocarbons and developed chloracne on top of an acid dermatitis When the dermatitis cleared up, the chloracne remained

The chlorobenzols and the chlorophenols are manufactured in a similar manner to the chloronaphthalenes and similar lesions of the skin are reported by Fuss to be caused by them.

PREVENTION OF DERMATOSES FROM SYNTHETIC WAXES

1 Manufacturing processes should be totally enclosed If this is not possible hoods with suction exhausts should be placed over open processes so that dust and fumes are drawn away from the worker and out of the room

2 The work rooms themselves should be ventilated by intake and exhaust fans to remove dust and fumes.

3. The floors walls ceilings and machines should be washed down or vacuum-cleaned at frequent intervals to keep them free from dust or wax.

4 Clean work clothes with long sleeves, long-legged underclothes, long-sleeved coveralls fastened at the neck and wrists protective gloves, and even gas masks for certain operations should be provided The clothes should be cleaned daily

5. Two lockers should be furnished to each worker, one for his street clothes and one for his work clothes. The lockers for street clothes and work clothes should be in separate rooms, with the shower baths situated between the locker rooms. In the morning the worker enters the locker room provided for his street clothes, takes them off, puts them in the locker. He then goes into the locker room where his clean work clothes are kept and puts them on, and from this room goes to work. At the end of his work shift he goes through this door to the work clothes locker room, takes off his work clothes, leaves them on the floor or on a bench to be picked up and washed, and then goes to the shower baths. Finally he dresses in the locker room where his street clothes are waiting for him. It has been estimated that, at one plant where such a system has been instituted, six cents a day per worker is the cost of furnishing clean work clothes each day.

Eating should be prohibited in the work rooms. Suitable eating places should be provided and the workers compelled to wash the hands and scrub under the nails before eating.

6. New applicants for jobs should be carefully examined for skin diseases and rejected if any lesions are present.

7. Workers with chlorinated naphthalenes and diphenyls should be examined periodically for the detection of acne and symptoms of systemic poisoning, and the air of the work rooms should be examined periodically for the detection of excessive concentration of these compounds.

TRADE NAMES OF SYNTHETIC RESINS

Name	Type
Abalyn	Methyl abietate varnish and lacquer resins
Aceloid	Celluloid and resinous plastic
Aceplas	Cellulose and resinous plastic
Acrada	Molded or fabricated acrylics
Acryloid	Acrylic resin solutions for coatings
Acrysol	Acrylic resin emulsions for coatings
Aero	Rosin-glycerol varnish and lacquer resins
Aero Qual-i-Lumarith	Cellulose acetate transparent sheeting for aviation
Aeropol	Vulcanizable, emulsifiable oil polymers
Akco	Phenolic varnish and lacquer resin
Alvar	Vinyl resins
Amberlac	Alkyd varnish and lacquer resins
Amberlite	*Phenol formaldehyde resin adhesives*
Amberol	Phenolic varnish and lacquer resins
Ameripol	Butadiene copolymer
Amerith	Pyroxylin
Ameroid	Casein
Amphenol	Polystyrene products and electrical connectors
Apla	Saran tubing and fittings
Aqualite	Phenolic bearing material
Aquaplex	Alkyd emulsion varnish and lacquer resins
Aquaresin	Glycol boriborate
Arcolite	Phenolic
Arochem	Soft oil modified alkyds
Aroclor	Chlorinated diphenyl varnish and lacquer resin
Aroplaz	Soft oil modified alkyds
Astex	Cotton fibre and phenolic resin
Bakelite	Plastic molding materials, phenolic, urea, cellulose acetate, and polystyrene; cast resinoid

TRADE NAMES OF SYNTHETIC RESINS—(*Continued*)

Name	Type
Bakelite C-9	Soft oil modified alkyds
Bakelite Cellulose Acetate	Cellulose acetate molding powder
Bakelite Polystyrene	Styrene resin
Bakelite Urea	Urea resin
Baker Cast Resin	Cast phenolic resin
Beckacite	Modified phenolic varnish and lacquer resins
Beckamine	Urea-formaldehyde varnish and lacquer resins
Beckolin	Synthetic oil lacquer and varnish resins
Beckopol	Phenolated copal varnish and lacquer resins
Beckosol	Synthetic oil varnish and lacquer resins
Beetle	Urea-formaldehyde materials
Benalite	Cured lignin sheets, lignin plastics
Benaloid	Lignin plastics, uncured lignin sheet
Bendalit	Cast styrene resin
Bondelite	Laminated phenolic
Bondex	Laminated phenolic
Bubblfill	Regenerated cellulose
Buna S	Butadiene copolymer
Burwood	Cold molded wood fiber plastic
Butacite	Polyvinyl butyral
Butvar	Polyvinyl butyral
Butyl Rubber	Isobutene diolefin copolymer
CR Resins	Allyl resins
Caffelite	Molding compound derived from green coffee bean
Carbofil	Starch covered with cellulose nitrate
Cardanol #53	A fraction of cashew nut shell liquid
Cardolite	Resins, rubbery polymers, plasticizers, solvent
Cascamite	Dry powder urea-formaldehyde resin glue
Cascophen	Powder or liquid phenol-formaldehyde resin glue
Casco Resin	Liquid urea-formaldehyde resin glue
Catabond	Phenolic laminating
Catalin	Cast phenolic
Catalin Melamine	Melamine resin
Catavar	Phenolic surface coating
Celeronite	Phenolic laminated
Cellophane (DuPont)	Regenerated cellulose wrapping
Cellucraft	Nitro cellulose spray coating
Cellulak	Shellac paper-laminated tubing
Cellulite	Cellulose acetate
Celluloid	Cellulose nitrate sheets, rods, tubes, rolls and films
Celoron	Molded laminated and macerated phenolic-impregnated fabric
Challenger	Acrylic denture material
Chemigum	Butadiene copolymer
Cibanite	Aniline-formaldehyde resin
Col-o-sil	Vinyl resin-coated fabrics
Coltrock	Phenolic
Coltwood	Phenolic resin-based compound utilizing either macerated paper, cotton or long fibre fillers (high impact)
Compleo	Shellac compounds
Compregnite	Liquid phenol-formaldehyde impregnating solution
Cronation	Casein plastic
Corprene	Synthetic rubber with ground cork, rubber derivatives and rubber-like resins
Crystalex	Acrylic denture base
Cumar	Coumarone-indene resins
Dilectene	Aniline-formaldehyde synthetic resin
Dilecto	Phenol-formaldehyde laminated products
Di Polymer	Coumarone-indene resin
Dulux	Varnish and lacquer resins alkyd
DuPont Modified Polyvinyl Butyral	Vinyl acetal resins

TRADE NAMES OF SYNTHETIC RESINS—(*Continued*)

Name	*Type*
Duraloy	Phenol formaldehyde laminated products
Durez	Phenol-formaldehyde molding compounds and resins
Durite	Phenol-formaldehyde and phenol-furfural molding compound and resins
Electrose	Shellac compound
Esterol	Varnish and lacquer resins alkyd
Ethocel	Ethyl cellulose
Ethofoil	Ethyl cellulose film
Exelon	Acrylic denture material
Fairprene	Chloroprene polymer for fabric coating
Falkyd	Soft oil modified alkyds
Fiberlac	Cellulose nitrate lacquer
Fibestos	Cellulose acetate
Flamenol	Polyvinyl chloride
Flexoresin	Glycol and glyceryl phthalates
Formica	Phenol and urea-laminated products
Formvar 15/95	Polyvinyl-formal
Formvar	Vinyl resins
G	Varnish and lacquer resins, glycerolphthalic anhydride
Gala	Casein plastic
Galorn	Casein plastic
Gelva	Vinyl resins
Gemlite	Urea-formaldehyde resin
Gemloid	Pyroxylin and cellulose acetate
Gemstone	Phenol-formaldehyde resins
Glycene	Alkyd denture
Glyptal	Varnish and lacquer resins alkyd
Halowax	Chlorinated naphthalenes
Harvite	Shellac compounds
Haskelite	Plywood bonded with phenolic resin
Haveg	Phenolic-asbestos molded composition
Hercolyn	Varnish and lacquer resins, hydrogenated methyl abietate
Hercose AP	Cellulose acetate propionate
Herculoid	Cellulose nitrate
Heresite	Phenol-formaldehyde molding compound
Horco X	Thermosetting polyvinyl butyral
Hycar OR 15, OR 25, OR-10	Butadiene copolymer
Imperial Latex	Rosin-glycerol varnish and lacquer resins
Indur	Phenol-formaldehyde molding compound
Insulate	Shellac compound
Ivaleur	Pyroxylin
Kodaloid	Cellulose nitrate
Kodapak	Transparent cellulose acetate foil
Kopol	Esterified copals varnish and lacquer resins
Koron	Polyvinyl chloride
Koroseal	Polyvinyl chloride
Lacanit	Shellac compound
Lamicoid	Phenol and urea laminating sheets, rods, tubes
Laminac X-4000	Modified alkyd
Lauxit	Urea-formaldehyde zinc chloride resin
Lewisol	Alkyd and phenolic varnish lacquer resins
Lignolite	Laminated lignin plastic
Limacra	Formica
Loaboard	Styrene laminating
Loalin	Styrene molding powders
Loavar	Styrene surface coating
Lotol	Compounded latex

Trade Names of Synthetic Resins—(Continued)

Name	Type
Lucite	Acrylate and methacrylate resins
Lucitone	Methyl methacrylate resin denture material
Lumarith	Cellulose acetate sheets, rods, tubes
Lumarith, Aero Quality	Transparent cellulose acetate sheeting
Lumarith E.C.	Ethyl cellulose sheets and molding powders
Lumarith E.R.	Ethyl rubber molding material
Lustron	Polystyrene molding compounds
Luxene 44	Vinyl copolymer denture
MR 1, 1A, 17A, 17B	Allyl resins or mod. alkyd
Macoid	Nitro cellulose dip coating
Makalot	Phenol-formaldehyde molding compounds and resins
Marblette	Phenol-formaldehyde cast resins
Marcolite	Allyl mod. alkyd
Marvinol	Combination vinyl chloride and additive
Melantine	Melamine resin
Melmac	Melamine formaldehyde molding compound, laminating resin and adhesive
Melocol	Polyamide formaldehyde
Melopas	Polyamide formaldehyde
Melurac	Melamine-urea formaldehyde laminating resin and adhesive
Methocel	Dow methyl cellulose
Micabond	Shellac or synthetic resin-bonded mica
Mirasol	Alkyd varnish and lacquer resins
Mic-rex	Laminated phenolic paper base
Modified Vinylite X	Thermosetting polyvinyl butyral
Neillite	Phenol-formaldehyde molding compound
Nevidene	Coumarone resins
Nevillac	Phenol coumarone resins
Neville	Coumarone-indene resins
Nevindene	Coumarone-indene resins
Nixonite	Cellulose acetate
Nixonoid	Cellulose nitrate
Norbo	Phenolic resin
Nuba	Resinous coal-tar pitch
Nypene	Polyterpene hydrocarbon resin
Nylon	Polymer of hexamethylenediamine adipate
Ohmoid	Laminated phenolic plastic, sheets, rods and tubes
Opalon	Phenol-formaldehyde resins
P.A.C.	Formaldehyde
PVA	Polyvinyl alcohol
Palatone	Acrylic denture material
Pana	Urea-formaldehyde
Panelyte	Laminated phenolic, sheet, rod, tubes, fabricated parts and molded specialties
Paracon	Polyester elastomer
Paradene	Coumarone-indene resins
Paradura	Varnish and lacquer resins phenolic
Paramet Ester Gum	Varnish and lacquer resins rosin-glycerol
Paranol	Varnish and lacquer resins phenolic
Paraplex X 100	Polyester elastomer
Para-shield	Acetate, ethocel and vinyl laminations
Parkwood	Urea phenol-treated woods
Perbunan	Butadiene copolymer
Perflex	Unstretched vinylidene chloride (Saran) and end products
Permalon	Stretched vinylidene chloride (Saran) and end products
Petrex	Varnish and lacquer resins terpene maleic anhydride
Phenac	Varnish and lacquer resins phenolic
Phenolite	Phenol-formaldehyde laminated products

TRADE NAMES OF SYNTHETIC RESINS—(*Continued*)

Name	Type
Phenoprег	Phenolic impregnated fabrics and papers
Piccolyte Resins	Terpenes
Piccoumaron	Varnish and lacquer resins terpene resin
Piccoumaron Resins	Coumarone indenes
Plaskon	Urea-formaldehyde molding compounds and plywood
Plaskon-900	Allyl modified alkyd for laminating
Plastacele	Cellulose acetate
Plastone-A	Cotton seed hull phenolic molding compound
Plexiglas	Acrylic resin sheets, rods, and molding powders
Plexigum	Acrylic resin for laminated glass
Pliofilm	Rubber hydrochloride—rubber derivative film and rubber-like resins
Plioflex	Polyvinyl chloride
Plitax	Wood and phenolic resin
Polectron	Vinyl carbazol resin
Polyflex	Flexible polystyrene sheet
Polypentek	Poly pentaerythritol
Primal	Acrylic resin for leather finishes
Proxyl	Pyroxylin denture
Prystal	Cast phenolic (clear)
Pyralin	Cellulose nitrate (pyroxylin)
Rauzit	Urea-formaldehyde varnish and lacquer resins
Rezzone	Alkyd varnish and lacquer resins
Resinox	Phenol-formaldehyde molding compound
Resistoflex	Polyvinyl alcohol
Resovin	Vinyl denture
Revolite	Cloth impregnated with phenolic resin
Reswood	Phenolic-laminated wood
Rhonit	Urea resin
Rhoplex	Acrylic resin for textile finishes
Saflex	Polyvinyl butyral
Saflex F	Vinyl formal sheets and compounds
Santolite	Varnish and lacquer resins—toluene sulfonamide formaldehyde
Saran	Generic term for molding and extrusion compound of polyvinylidene chloride
Spauldite	Phenol-formaldehyde laminated products
Staybelite	Hydrogenated rosin-varnish and lacquer resins
Structomold	Phenolic paper laminate
Styraloy 22 [illegible]	Elastomeric-styrene derivative
Styron	Polystyrene
Super Beckacite	Pure phenolic varnish and lacquer resins
Super Harbord Plywood	Phenol formaldehyde binder
Sylphrap	Regenerated cellulose
Sylplast	Urea formaldehyde resins, lacquers and coatings
Syntex	Soft oil-modified alkyd
Synthane	Phenol-formaldehyde laminated product
Synthol [illegible]	Extruded vinyl chloride
Synvarem	Phenol formaldehyde-resin adhesive
Syn[illegible]rol	Urea formaldehyde-resin adhesive
Taylor	Phenol-formaldehyde laminated product
Tec	Cellulose acetate varnish and lacquer resin
Teglac	Alkyd varnish and lacquer resins
Tego	Phenolic resin for plywood
Tenite I	Cellulose acetate molding compound
Tenite II	Cellulose acetate butyrate molding compound
Thermocast	Ethylcellulose material
Thiokol A, B, D, F, FA	Organic polysulfide
Tolex	Vinyl resin-coated leather cloth
Turex	Vinyl resin-coated leather
Tygon F	Furan resin
Tygon T	Modified vinyl

TRADE NAMES OF SYNTHETIC RESINS—(*Continued*)

Name	*Type*
Ueralite	Phenol-formaldehyde laminated products
Uformite	Urea-formaldehyde molding compounds and resins
Uniplast	Phenol-formaldehyde molding compound
Urac	Urea-formaldehyde adhesives
Varcum	Phenolic resins of all types
Veo	Vinylidene chloride resin
Vernonite	Acrylic denture base
Versilex	Transparent vinyl chloride acetate
Victorium	Lignin thermoplastic materials
Vinsol	Modified resin varnish and lacquer resins
Vinylite Resins	Polyvinyl acetate polyvinyl chloride-acetate polyvinyl chloride
Vinyl-seal	Vinyl acetate resin adhesives
Vinylseal Adhesive Solution	Polyvinyl acetate and modified polyvinyl acetate solutions
Vinyon	Vinyl resins for textile fibers
Vistanex	Isobutene polymer

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CHAPTER XXXIII

DERMATOSES IN THE MANUFACTURE OF RUBBER

DERMATITIS has been known to exist in the rubber industry for a long time, the terms "rubber itch" and "rubber poisoning" being commonly applied to the condition.

R. Prosser White states that hexamethylenetetramine is the most active cause of dermatitis in the rubber industry. He also names aniline, paraphenylenediamine, thiocarbonilide, and paranitroso-dimethylaniline as causes of dermatitis. (Fig. 99.) He further states that the compounders, mixers, and calenderers are chiefly affected by the action of these skin irritants; also that in hot weather hexamethylenetetramine dissolved in the slightly acid perspiration is changed into formaldehyde and the latter oxidized to formic acid which causes the actual irritation of the skin. A 1 per cent solution of hexamethylenetetramine is sufficient to cause dermatitis.

Kober and Hayhurst state that about 3 per cent of all the workers in the rubber industry are affected with dermatitis. D. E. Cleveland has reported dermatitis consisting of large vesicles on both hands and forearms resulting from hexanitro-diphenylamine. He states that aniline oil is an even more toxic accelerator. R. S. Quinby states that the chief hazards in the rubber industry are lead, benzol, aniline and urotropine; also that antimony pentasulphide, para-nitroso-dimethylaniline, and all sulphur chlorides cause dermatitis. H. J. Cronin has observed that stearic acid mixed with lead oxide and sulphide to soften rubber produces dermatitis. Lothar E. Weber, in enumerating hazards of the rubber industry, names litharge as the most dangerous health hazard, and yellow pigment next. Others are arsenic sulphides, gasoline, benzene, carbon disulphide, sulphur chloride, and paraphenylenediamine.

National Safety Council Transactions name a long list of chemicals used in the rubber industry as dangerous. They also state that compounding is rated as one of the most hazardous processes in the industry, and that insurance companies class compounders among those whose mortality is expected to run from 50 per cent to 100 per cent above the average. Mixing room workers are thought to be exposed to similar hazardous compounds.

J. S. Millard stated that when dermatitis was caused by hexamethylenetetramine, the individual became sensitive to that irritant and was likely to react with dermatitis to a far slighter exposure than was necessary to produce the original attack. He divided the causative factors in the rubber industry into mechanical and chemical, and stated that the mechanical irritants were inert substances such as soapstone and zinc oxide. These had a drying effect upon the skin and caused it to become dry, thickened, and

often attended by intense itching He advised protecting the skin in the early stages with a bland ointment applied before going to work each day and again at night for a period of two weeks or until the skin adjusted itself to the occupation. After this the ointment was seldom needed The chemical irritants he named were sulphur chloride and hexamethylenetetramine and he stated that a protective ointment containing an alkali was found to be helpful in preventing dermatitis from hexamethylenetetramine He observed the dark oily-skinned individuals were preferable to blondes for occupations in which dermatitis occurred and that negroes were entirely immune

FIG. 99 — Dermatitis from paranitroso dimethylaniline rubber compound.

L. J D Healy gives a list of compounds used in the rubber industry and classifies them in groups according to their toxicity as follows

Group A—Highly toxic.
Group B—Moderately toxic.
Group C—Slightly toxic
Group D—Low relative toxicity no hazards on ordinary handling

He sent out a questionnaire to manufacturers asking them to name some of the newer accelerators and anti-oxidants which caused dermatitis or toxic symptoms The following substances were named

B B Accelerator A condensation product of butyl aldehyde and dimethyl paraphenylenediamine

Furac No 2 Zinc salt of dithiofuric acid

Grasselerator No 102 Contains hexamethylenetetramine

Para Nitroso Dimethylaniline Base B C

Safex A patent accelerator marketed as a dry yellow powder

Super Sulphur No 2 An oxidized lead salt of dimethyl dithiocarbonic acid

Trimene Base A polymerized condensation product of formaldehyde and ethylamine The trimene contains traces of hexamethylenetetramine as an impurity

Fig. 70 — Rubber compound dermatitis. (Nitro-captax.)

Tuads A grayish crystalline substance with a melting-point of 150° C. (Fig 70) It is an oxidized product of carbon disulphide and dimethylamine. It causes inflammation of the membranes of the nose especially in persons susceptible to hay fever

K R Moore reported that in 7 factories employing about 5 000 workers in Australia dermatitis occurred only in 2 factories and was due to contact with paraphenylenediamine and hexamethylenetetramine The dermatitis ceased when these two substances were discontinued He stated that hot unvulcanized stock brought out the action of these irritants on the skin the perspiration reacting with hexamine to form formic acid

W S Burrage performed intradermal skin tests upon employees in a rubber factory having dermatitis due to their work and concluded that investigation not only from the chemical point of view but also from the viewpoint of allergy was indicated

P A Davis gives the formulae of chemicals used in the rubber industry and states that antimony arsenic ethyl acetate thiocarbanilid guanidine and their compounds may cause dermatitis.

Outbreaks of dermatitis among rubber workers have also been caused by aniline and paraphenylenediamine However aniline

paranitroso dimethyl aniline and paraphenylenediamine are no longer used in the rubber industry because they have caused dermatitis among a considerable percentage of workers.

Up to 1926 dermatitis had been very prevalent among the rubber workers in the United States but since then the number of cases has materially diminished This is due to the fact that a large number of rubber manufacturers have discontinued the use of well known irritating accelerators and anti-oxidants and are now using less harmful chemicals. The installation of modern machinery and manufacturing methods which keep the workers from contact with irritating chemicals also has tended to diminish dermatitis among rubber workers

Rubber is derived from a milky substance called latex which exudes when incisions are made in the bark of the rubber tree Rubber consists of from 86 to 88 per cent of the hydrocarbon (C_5H_8) about 1 to 3 per cent of resins from 5 to 10 per cent of protein some mineral matter and enzymes. The commercial rubber is almost exclusively obtained from the tree known as *Hevea brasiliensis* Small quantities of rubber are obtained from other varieties of rubber trees. Some of these are *Castilloa elastica* *Castilloa ulei* *Manihot glaziovii* and *Funtumia elastica* Gutta percha is derived from the genus *Dichopsis* and Balata is obtained from the *Mimusops globosa.*

Latex is obtained by tapping the tree and placing a tin cup at the bottom of the incision to collect the latex. The latex of South American Para rubber is cured by exposing it over a fire of the nuts of the Urucuri palm Over the burning nuts there is placed a tapped funnel of earthenware through which a dense smoke pours out A flat wooden paddle is dipped into the latex picks up a thin layer of it and is rotated through the smoke The process is repeated again and again until a biscuit of rubber weighing from 25 to 100 pounds has been built up on the paddle This method of curing deposits the products of combustion (acetic acid creosote, and tarry matter) between each layer of the biscuit Dermatitis has occurred among workers with this rubber especially among makers of adhesive plaster who break up and wash the rubber biscuits and are exposed to these irritants. In a study of the irritants in adhesive plaster by Schwartz and Peck it has been found that South American Para rubber is irritating to the skins of 25 per cent of those susceptible to dermatitis from adhesive plaster

Latex for the manufacture of plantation rubber instead of being coagulated and cured over a fire is usually coagulated by the addition of acetic acid although other coagulants such as formic acid may be used After coagulation the rubber is padded between rolls to squeeze out excess serum and then passed through a marking roll which imprints the usual design on the rubber The sheets are then washed and transferred to the smoke house where they are exposed to the smoke of cocoanut husk or hardwood fuel. The purpose of the smoking is to render the rubber aseptic otherwise

the serum remaining on it undergoes fermentation. Dermatitis is less likely to result from handling plantation rubber than from handling South American Para rubber because there are less of the products of combustion deposited on it

Crepe rubber differs from plantation rubber in that all the serum is squeezed and washed out of the rubber It is not smoked and also differs in that it is of a light color due to the sodium bisulphite added to bleach the latex before the addition of acetic acid The crepe effect is obtained by passage between macerating rollers The authors have not seen any dermatitis attributable to handling crepe rubber

In order to make rubber serviceable various compounds are added to it. Sulphur is the one compound which is essential to all rubber manufacture but there are hundreds of other compounds incorporated in the rubber to give it such properties as hardness resistance to abrasion weight color etc.

Rubber must also be vulcanized or cured in order to make it serviceable. Sulphur sulphur monochloride selenium and various other compounds are used to vulcanize rubber The compounded rubber can be vulcanized by steaming or immersion in hot water immersion in a solution of sulphur monochloride in carbon bisulphide or exposure to the vapor of sulphur monochloride depending on the quality and thickness of the rubber to be produced Rubber for heavy wear such as rubber tires etc. is cured by heat and pressure while thin rubber goods such as surgeons gloves, can be cured by exposure to the vapors of sulphur monochloride. Various chemical compounds are used to accelerate the process of vulcanization These substances are known as accelerators. Other compounds are used to prevent the decomposition or oxidation of rubber and are known as anti-oxidants. The following is a list of compounds which are used in rubber and may cause dermatitis

Inorganic Compounds.

1 Coarse talc the sharp metal-like crystals of which may irritate the skin
2. Limestone whiting a form of calcium carbonate and lime
3 Chrome pigments.
4 Antimony in the form of antimony trichloride and antimony pentasulphide
5 Sulphur and sulphur monochloride

Organic Compounds.

1 Anti-oxidants.
2 Accelerators.
3. Plasticizers
4 Tar
5. Resins.
6. Aniline dyes.

Before the crude rubber can be used, it must be first washed clean of extraneous matter This is done by cutting it into small

sizes and passing it through roller mills meanwhile washing it with water. Dermatitis may occur among the washers from the products of combustion incorporated in South American Para and plantation rubber.

After the rubber is washed it is milled to make it into a homogeneous mass. This consists in passing it between rollers moving in opposite directions. After milling the rubber is mixed with the various compounds and again milled in the mix mills to thoroughly incorporate the compounds into the rubber. The workers in the compound room who weigh and issue the chemicals and the workers on the mix mills are exposed to the action of whatever irritating chemicals are used and often develop dermatitis. (Figs. 71 and 72.)

FIG. 71.—Dermatitis caused by rubber compound penetrating the clothing. Compound room worker.

After going through the mix mills the rubber is ready to be molded into whatever material is to be made. In making tire treads or automobile tubes the rubber is forced through suitable dyes. When impregnating fabric with rubber the sheets of rubber are pressed into the fabric in a calendering machine. As the rubber comes through the dyes of a tread or tube-making machine or when it comes off the calender it is hot and the workers who handle it often suffer from dermatitis caused by contact with the compounds in the unvulcanized rubber.

Tire builders are also exposed to the compounds in the unvulcanized rubber and are often affected with dermatitis. The builders of heavy truck tires often suffer with painful cracks and callouses (Fig. 73) of the hands as a result of their occupation and with papular and vesicular dermatitis of the hands and forearms as a

result of sensitivity to the compounds in the rubber In some factories which manufacture automobile tubes, when the rubber comes out of the tube machine it is placed on circular forms called "mandrels and then put into the vulcanizer for curing The workers

Fig. 72.—Dermatitis—chemical work with mercapto benzo thiazole

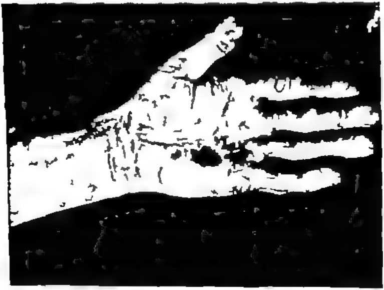


Fig. 73.—Dermatitis of tire builder hands and arms due to rubber compound. Also callosities due to hard manual labor

who pull the tubes on and off the mandrels develop heavy callouses on the palms and over the last joints of the fingers due to constant friction against the tube and the mandrel. The finger nails are also worn down to the quick from grasping and pulling on the tubes

Thin rubber goods such as toy balloons and surgeons' gloves are usually made by the dipping process. After the rubber is compounded and milled it is dissolved in naphtha or benzol and the solution is placed in receptacles. Metal forms are dipped into the solution and a coating of rubber is deposited on the forms. They are then taken out and allowed to dry. They are re-dipped and dried many times to acquire the desired thickness of rubber. When this is obtained it is cured by dipping the form in a solution of sulphur monochloride in carbon disulphide or by exposure to the vapor of sulphur monochloride in a closed chamber. After exposure this is neutralized by the vapor of ammonia.

FIG. 74 — Dermatitis [illegible] chemical worker caused by [illegible] hypersensitivity [illegible] and red rubber gloves worn for protection against skin [illegible]tant. (Case of Dr. D. O. Hamblin.)

Systemic poisoning from carbon disulphide has occurred in the first process as well as dermatitis from sulphur monochloride. In curing the rubber with sulphur monochloride a deposit of hydrochloric acid may form on the rubber and this may be the actual irritant which affects the skin of workers who handle vapor-cured rubber. (Fig. 74.)

A process called the "Anode Process" for the manufacture of thin rubber goods consists in dipping a metal form into a solution of rubber and turning on an electric current. This results in the deposition of rubber on the metal form.

Another method is to dip a porcelain form into a solution called

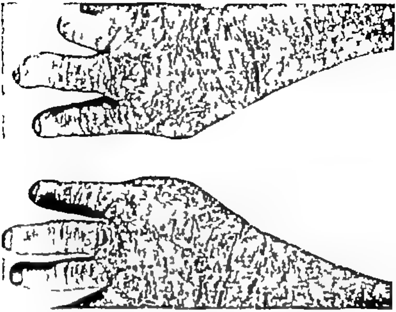
gel and then immerse the form in a solution of rubber A reaction takes place between the "gel and the rubber solution which results in the rapid deposition of rubber on the form Dermatitis is comparatively rare from rubber goods manufactured by these two processes.

Rubber acts as a solvent for certain materials and it is a better solvent when hot. Thus, when rubber is vulcanized under heat and pressure it dissolves more chemicals than when it is cool. As a result, if an excess of materials is dissolved in the rubber it is thrown out of solution on cooling and forms what is called 'bloom on the surface of the rubber and free crystals in the substance of the rubber Bloom forms when there is a surplus of free material above the saturation point of the rubber Usually the "bloom" is the unchanged compound present in excess It is possible however that the 'bloom may contain compounds formed in the rubber during the vulcanizing process. "Bloom" is usually an undesirable product although in some rare instances, as in the case of the paraffin bloom it may be useful in that it protects the rubber Cases of dermatitis among the users of rubber goods are often attributed to 'bloom.

In an examination of 3 plants employing about 28 000 workers it was found that about 1 per cent of the workers per year had an occupational dermatitis of a sufficient severity to cause a lay-off from work. There were about ten times this many who had dermatitis which was not of sufficient severity to cause them to stay away from work It was noted that most of the cases occurred among workers handling rubber compounds and uncured compounded rubber Comparatively few cases occurred among workers with uncompounded raw rubber or with compounded cured rubber Most of the cases of dermatitis found among those workers who handled cured rubber were due to rubber solvents such as naphtha and benzol and to the sulphur monochloride left on vapor-cured rubber There was only one case possibly caused by vulcanized compounded rubber

Boils on the arms and legs of workers in the mixing mill rooms (Figs. 75 and 76) and the compound rooms and where soapstone or talc was used were of frequent occurrence Most of the dermatitis however was due to the accelerators and the anti-oxidants. Among the accelerators used hexamethylenetetramine was the one found to cause the most dermatitis. In one plant where "hexa" was used in only small quantities from 1927 to 1929 there was an average of only 34 cases per year of occupational dermatitis In 1930 this plant began to use "hexa" extensively in one part of the plant to replace an unsatisfactory accelerator and during that year the cases of occupational dermatitis increased to 50. When the use of 'hexa" was discontinued the cases of dermatitis again diminished.

In one factory where "hexa" was used as an accelerator in a certain rubber stock, it was noted that a considerable number of the girls who handled this stock developed dermatitis. Patch tests



F o. 75.—Dermatitis in the duster in a rubber factory (Case of Drs. Foerster and Wueder.)

Fig. 76.—Dermatitis in rubber worker due to dirty and greasy overalls.

showed that they were sensitive to the "hexa." A number of the workers stated that when they first began to work with hexa they developed a dermatitis, but that later they became hardened to it.

Diortho tolyl guanidine diphenyl guanidine triphenyl guanidine Sym. di beta naphthyl paraphenylenediamine and dimethyl para phenylenediamine, tetra methyl thiuram disulphide tetra methyl thiuram monosulphide, mercapto benzo thiazol, hexa dinitro phenylamine thio carbanilide, paranitroso dimethyl aniline phenylhydrazine zinc chloride and triethyl trimethyl triamine are some of the accelerators found to cause dermatitis.

E. E. Williams reports that workers with tetramethylthiuram monosulphide and tetramethylthiuram disulphide develop flushing of the face and hands fullness of the head rapid pulse and dizziness upon drinking any alcoholic liquors These symptoms are very similar to those described by Schwartz among workers with calcium cyanamide on partaking of alcohol in any form. Pack states that in manufacturing tetramethylthiuram disulphide the intermediate paranitroso dimethylaniline chlorhydrate is formed and has caused a papulo-vesicular dermatitis

Among the anti-oxidants meta toluylene diamine phenyl alpha naphthylamine and phenyl beta naphthylamine have been found to irritate the skin of sensitive workers. Sensitivity may occur to any of the accelerators or anti-oxidants used in rubber This was well illustrated when an outbreak of leukoderma occurred among those wearing rubber gloves of a certain make Patch tests and observation over a period of several months showed that an anti-oxidant monobenzylether of hydroquinone was the chemical in the gloves which caused the leukoderma.

RECLAIMED RUBBER

Old rubber goods are treated to reclaim the rubber which is used in the manufacture of rubber articles such as rubber flooring rubber *tiling* etc.

Light rubber goods such as aprons and gloves are usually reclaimed by the acid method This consists in cutting up the rubber into small pieces, removing extraneous matter and boiling in a solution of sulphuric acid This destroys whatever fabrics may be in the rubber The acid solution is then drained off the rubber washed in water further cleaned of extraneous substances, and the remaining rubber de-vulcanized and plasticized by heating and mixing with mineral and vegetable oils

Heavy rubber scraps such as automobile tires and hose is reclaimed by the alkali process. After being cut up and having extraneous matter separated from it, it is subjected to the action of a solution of caustic soda and heated. After a suitable period of time the excess of caustic soda solution is discharged and the rubber mass is washed dried and worked in a mill. The alkali process removes the sulphur which the rubber contains and destroys the fabric.

Dermatitis among the workers in the reclaiming department is rare. The acid and alkali processes are totally enclosed and very little of the irritants are left on the rubber by the time they are ready for the mills.

SYNTHETIC RUBBER

When the war cut off our principal supply of natural rubber from the East Indies it was necessary to find a substitute in order to carry on the war successfully. For more than twelve years before the war the DuPont de Nemours Company had made neoprene, the first of our synthetic rubbers. Shortly before we entered the war the Standard Oil Company of Louisiana obtained the German patents for making buna S, the type of rubber now mostly used.

The principal types of synthetic rubbers now manufactured in this country are buna S, buna N, butyl rubber and neoprene. Buna S, butyl rubber and neoprene are the types now being made for our armed forces.

Buna S.—Buna S is made from butadiene and styrene. Butadiene can be made from alcohol and from butylene, a product fractionated from high line gas and light pressure distillate taken from petroleum oil.

Butadiene From Alcohol.—Ethyl alcohol is heated in closed kettles over a catalyst and converted to acetaldehyde. The acetaldehyde is heated over a catalyst to form butadiene. These processes take place in closed kettles and there are no exposures of the workers to the chemicals because the operation is controlled from a control room. However, in cleaning the kettles and reactors the maintenance crews come in contact with some of the chemicals formed during the conversion, and cases of dermatitis have occurred chiefly from acetaldehyde. Among the other chemicals and by-products which may be encountered in cleaning retorts and kettles the irritants are butylaldehyde, methylethyl ketone and acetic acid.

Tertiary butyl catechol is added to the butadiene in order to keep it from polymerizing while in the storage. Tertiary butyl catechol is a skin irritant, and workers opening the cans containing this product may develop dermatitis from splashes if they do not wear rubber gloves and impervious sleeves and aprons.

Butadiene is a volatile gas under ordinary conditions of temperature, and any dermatitis resulting from it is probably due to the freezing effect of its evaporation.

In plants making butadiene from ethyl alcohol, maintenance workers going into kettles, retorts or pipes for cleaning or repairing should wear rubber gloves, goggles, airline respirators, or gas masks, impervious coveralls and boots. They should step under the shower with all these clothes on immediately after completing the job in the retorts and then remove the protective clothing and don their street clothes.

While handling tertiary butyl catechol, workers should wear

goggles, rubber gauntlets and rubber aprons which should be kept close by the tank in which the cans are opened and melted

Butadiene From Butylene.—Butylene is heated to a high temperature in reactors in contact with a catalyst resulting in the formation of butadiene. The entire process is totally enclosed and automatically controlled Skin hazards are present only to maintenance men cleaning or repairing the reactors. When such work is being performed the men should be protected as prescribed for maintenance men making butadiene from alcohol.

Styrene Manufacture.—Ethylene is combined with benzene in order to form ethylbenzene. Aluminum chloride is used as a catalyst in this operation. The aluminum chloride is dumped into the hopper by hand and the worker is exposed to it twice during a shift. Since aluminum chloride is a skin irritant the worker while engaged in handling it should wear rubber gauntlets aprons and goggles Sodium hydroxide is used in the process. Workers handling the caustic should wear rubber gauntlets aprons and safety goggles. The waste discharged from the reaction of ethylene with benzene is a black tarry irritant substance. Therefore workers handling this waste should also wear rubber gloves, impervious sleeves and aprons. They should be instructed to change their clothes immediately after they become soiled with this tarry material Ethylbenzene is heated over a catalyst to form styrene. This process is totally enclosed. Tertiary butyl catechol is added to styrene to prevent polymerization while in storage While handling this chemical the workers should wear goggles rubber aprons and gauntlets.

Manufacture of Buna S—Buna S is made by stirring a mixture of butadiene styrene soap solution, an oxidizing salt and a chain modifier in a polymerization kettle for about eighteen hours. Hydroquinone also is used The unreacted styrene and butadiene are recovered from the latex. The anti-oxidant is then added to the latex The latex is coagulated by acidification and the rubber is screened out of the liquor washed, dried baled powdered and packed. The butadiene and styrene are usually brought to the plant in tank cars. Workers engaged in emptying the styrene tank cars should wear impervious protective clothing to protect them from accidental splashes The process of removing tertiary butyl catechol from butadiene by bubbling it through a solution of caustic soda entails no hazard because it is totally enclosed The red liquid sodium salt of tertiary butyl catechol is disposed of by burning

Most of the occupational dermatitis occurring in the manufacture of buna S is caused by chemicals added to the butadiene and styrene in order to make the reaction possible These chemicals are as follows (1) The persalt which is used as an oxidizer or catalyst rarely causes dermatitis. (2) The chain modifier which is added to the mixture in the polymerization kettle is a primary irritant and sensitizer (3) Hydroquinone which is added to the latex in the polymerization kettle, is a sensitizer (4) The anti-oxidant usually consisting of phenylbetanaphthylamine is a sensitizer (5) Bardol a

coal tar derivative is sometimes added to the phenylbetanaphthyl amine Bardol is a primary irritant and photosensitizer (6) Soapstone or talc is used to cover the bales of rubber Dermatitis can result from coarsely powdered soapstone especially in hot weather (7) The compound which is sometimes used as a modifier instead of or in conjunction with the original modifier is also a primary skin irritant. (8) Sodium lignin sulphonate sometimes used is a sensitizer

Workers in the pigment room handling these chemicals should wear protective clothing in the form of rubber gauntlets impervious sleeves and aprons. Workers dumping chemicals into reaction kettles should wear similar protective clothing

Workers engaged in handling the baled rubber are exposed to soapstone and talc and often develop dermatitis. The talc and soapstone are usually coarse and contain sharp spicules which wound the skin especially when it is perspired and macerated Unless some method is devised whereby the dust exposure to the workers is eliminated such workers should wear closely woven coveralls and leather gloves cleaned daily in the plant. They should also be compelled to take shower baths after work. In some plants a very fine grade of talc is used fine enough to pass through a 300 mesh screen In such plants there is no dermatitis from talc.

Dermatitis also occurs among workers making the coagulating solution In warm weather this solution deposited on the perspiring skin of the arms can cause dermatitis Protective sleeves will prevent this condition

Workers engaged in making the soap solution may also develop dermatitis from the soap flakes Protective sleeves and aprons will prevent this

A considerable portion of the dermatitis occurs among the workers engaged in cleaning the driers. They are compelled to enter the driers and lie on their backs in closely confined spaces, removing from the traveling chain or belt the adherent, incompletely polymerized rubber Dermatitis occurs on the body of these workers and is caused by the incompletely polymerized rubber and the uncombined chemicals which it contains

About 0.5 per cent of the styrene remains unchanged in the rubber as it comes from the drier The phenylbetanaphthylamine in the incompletely polymerized rubber combined with the bardol sodium lignin sulphonate and soon are probably the principal causes of dermatitis among workers cleaning the driers. The faces of these workers should be protected by a protective ointment of the lanolin-castor oil type They should be furnished with clean coveralls and gloves and take compulsory showers after each session in the driers. The future driers should be roomy and so constructed that the workers can clean them in a standing position Samplers of latex in the reactor building should wear rubber gauntlets, impervious sleeves and aprons while drawing fluid from the reactors. Workers dipping their hands into the slurry of rubber brine, latex and acid

in the coagulation building should wear rubber gauntlets. In some plants soda ash is added to soften the water used in making the soap solution and the brine. Workers coming in contact with soda ash should be furnished with impervious coveralls and rubber gloves daily cleaned at the plant, and should be compelled to take showers after work.

Neoprene.—There is comparatively little dermatitis in the manufacture of neoprene. The principal type of neoprene manufactured is called type G. R. M. and is made from acetylene. This is converted into vinyl acetylene by the use of a catalyst. The reaction takes place in retorts placed behind explosion proof walls and is remotely controlled. Vinyl acetylene is a gas with a boiling point of 5° C. Vinyl acetylene is reacted with hydrochloric acid to form chlorobutadiene. Chlorobutadiene is a liquid with a boiling point of 60° C. It is a primary irritant, and accidental splashes cause erythema even if it is soon washed off with water. Chlorobutadiene is mixed with sulphur and rosin placed in a kettle of soap solution to which a persalt is added as a catalyst and is agitated for about two hours to form neoprene latex. In emptying the kettles some of the latex spills on the floor and dermatitis occurs on the feet and legs of operators from contact with the latex. The latex contains unreacted chlorobutadiene, the pungent odor of which is present in the building. The latex has a pH of 10, which also adds to its irritant properties. About 5 per cent of the workers exposed to chlorobutadiene have some temporary loss of hair. It is not known whether this is caused by a local or a systemic effect. The hair becomes normal after exposure ceases.

The neoprene latex is deposited into cooled revolving drums which coagulate the neoprene and roll it off in a thin sheet. The sheet is washed and then passed festoon fashion through a drier. After coming from the drier it is compressed into roll form, passed through finely ground talc, cut into lengths of about 12 inches and packed into bags. There have been no cases of dermatitis among the workers exposed to the finely ground talc.

Other types of neoprene are type C. N., type I, type K. N. and type F. R. These differ somewhat in composition. Neoprene latex is made from type C. N. and is simply the uncoagulated latex. The latex liquor is made from rosin soap and has a pH of 9–10. It also contains a small amount of unreacted chlorobutadiene.

Butyl Rubber.—Butyl rubber is made from isobutylene and isoprene. These chemicals are dissolved in methyl chloride and reacted over a catalyst (aluminum chloride). The liquid is circulated and cooled in a reactor through metal tubes. As the rubber is formed it rises to the top of the reactor, where it meets a stream of steam which carries the rubber away. Phenylbetanaphthylamine is added to the slurry of hot water and rubber. The worker adding the phenylbetanaphthylamine should wear rubber gauntlets, impervious sleeves and aprons. The rubber is screened out of the slurry and then passed through a drier, from which it is extruded in a con-

tinuous sheet. Xylyl mercaptan is added to the rubber before it passes through the extruder This substance is a skin irritant and the workers at the extruder should wear impervious sleeves and aprons, and a protective ointment on the face The rubber after coming from the extruder is passed through a hot mill The workers on the mill develop burns and blisters of the hands from the hot rubber and dermatitis from the fumes of phenylbetanaphthylamine and xylyl mercaptan They should be provided with heat proof gloves and a protective ointment for the face

Buna N.—Buna N is made by reacting butadiene with acrylonitrile in a manner similar to that described for the manufacture of buna S Buna N is partially dehydrated in a centrifuge or by pressing between rollers before being passed through the drier The temperature of the drier is higher than that for buna S and the time of drying is less. Practically all the unreacted monomers remaining in buna N are vaporised in the drier and drawn off by suction The driers are roomier and do not require as frequent cleaning as do the driers for buna S and the workers entering the drier are not required to lie on their backs and work in narrow spaces. The raw chemicals used in the manufacture of buna N are (1) butadiene (2) acrylonitrile (3) soap suds containing a wetting agent (4) a modifier (5) a catalyst which consists of oxidizing salts (6) an anti-oxidant which may be phenylbetanaphthylamine or phenylalphanaphthylamine or stalite (7) sulphuric acid in a concentration of 0 5 to 1 per cent used to coagulate the latex (8) a 2 per cent barium chloride solution which may also be used for this purpose and (9) bone glue and casein used as emulsifiers

Dermatitis may occur from acrylonitrile which may leak out of enclosed pipes and retorts The soap solution containing a synthetic wetting agent may cause irritation of the nose and throat. The modifiers are primary skin irritants The anti-oxidants are sensitizers Barium chloride may cause a dry scaling eczema of the palms.

The whole operation of making buna N is more enclosed than that for making buna S and despite the fact that acrylonitrile is a powerful skin irritant there were no cases of dermatitis seen in the buna N plant which was inspected

Processing Synthetic Rubbers.—The skin hazards occurring in the processing of synthetic rubbers are the same as those described for natural rubber namely from the chemicals used in the rubber with the addition of hazards from the synthetic rubber themselves The chemicals to be used in the rubber are weighed out by hand The worker comes in contact with all of them and should be protected with rubber gloves impervious sleeves and aprons and a respirator The rubber either synthetic natural or reclaim and the chemicals are mixed into master batches which contain a high percentage of the ingredients. These master batches are the ones used for compounding the actual rubber stock

The chemicals to go in the rubber are mixed together either in

a mixing mill or a Banbury mixer. The workers on the mixing mills come in contact with the chemicals and are exposed to whatever fumes may come off the rubber as it gets hot, and sensitization dermatitis may occur among them. The mix mills should be well exhausted and those workers who become sensitized and develop dermatitis should be provided with a protective ointment of the water repellent type. Protective clothing is too hot to wear at this operation. Workers on the Banbury should wear clean dustproof coveralls furnished daily by the plant. Workers on the mix mills and the Banbury should take cleansing showers before going home. In most factories the rubber after being compounded is sheeted out and passes overhead in a continuous sheet to the various departments, where it is further processed.

Rubber which is going to be made into tires is extruded in the form of the tread. The fabrics such as cotton and rayon, going into tires are impregnated with rubber either by calendering or by dipping into water dispersions. These operations are automatic and there are no particular skin hazards connected with them.

Rubber to be made into tubes is extruded through a tube shaped die, cut off into suitable lengths and cemented into circular tubes. Workers engaged in this operation sometimes get dermatitis from the rubber cement, which consists essentially of rubber dissolved in a solvent. Workers at this operation who develop dermatitis should wear thin washable leather gloves and use a long handled brush for applying the cement.

Tire builders handle fabrics impregnated with rubber and the various compounded rubbers which go into the tread and sides of the tire. They rarely develop sensitization dermatitis from the chemicals in the rubber.

The synthetic rubbers can be used in latex form. Thin rubber gloves may be made directly from latex in the same manner in which they are made from natural latex. Dermatitis may occur from synthetic latex because it contains more of the uncombined and unpolymerized chemicals than does the coagulated dried rubber.

Patch Tests.—Hundreds of patch tests were performed on workers having dermatitis in the twenty plants inspected. Of twenty-four chemicals used as patch tests, the following positive reactions were obtained:

Phenylbetanaphthylamine, anti-oxidant.
Stalite, anti-oxidant.
Hydroquinone.
Buna S from driers.
Neoprene latex.
Safex (2, 4 dinitrophenyl dimethyl thiocarbamate), accelerator.
Captax (mercapto benzo thiazole), accelerator.
Erie (bis- 4, 6- dimethyl thiazyl disulphide), accelerator.
Altax (benzothiazole disulphide), accelerator.
Santocure (benzothiazyl 2, monocyclohexyl sulphonamide), accelerator.
Asphalt.
G. R. S.
Buna N type of synthetic rubber.

Summary —There is comparatively little dermatitis occurring in the manufacture of synthetic rubber despite the many irritant chemicals used This is explained by the fact that the factories making synthetic rubbers are modernly equipped with mechanical safety devices and most of the safety recommendations made in this chapter are already being carried out

We need to anticipate but little more dermatitis from the manufacture and processing of synthetic rubbers than we have had from natural rubbers provided future plants are erected with the same careful planning as the present ones and the safety recommendations in this chapter are carried out

TRADE NAMES OF SYNTHETIC RUBBERS

Buna S.	Copolymer of butadiene and styrene
Buna N	Copolymer of butadiene and acrylonitrile
Buna 85	Butadiene polymerized in the presence of metallic sodium
Buna 115	Same as 85 except of higher molecular weight
Perbunan, Hycar Ameripol Chemigum	Copolymers of butadiene and acrylonitrile
Neoprene G R. M	Polymerized chlorobutadiene
Neoprene G N Neoprene I Neoprene K. N Neoprene F R	Differ slightly from G R. M.
Butyl rubber	Copolymer of isobutylene and isoprene
S. K. A and S K B	Butadiene polymer (Russia)
Ker	Butadiene polymer (Poland)
Sooprene	Polymerized chloroprene (Russ)
Mustone	Polymerized chloroprene (J pan)
Vistanex	Polymerized isobutylene
Oppanol	Polymerized isobutylene (Germany)
Flexon	Copolymer of isobutylene and isoprene
Thiokol	Organic polysulphide
Ethanit	Organic polysulphide
Perduren	Organic polysulphide
Pliofilm	R bber hydrochloride
Vinylite	Copolymer of vinyl chloride and inyl acetate
Koroseal	Polymer of vinyl chloride

RUBBERIZED CLOTH

Rubber is also spread on fabric for various purposes. This is done by dissolving the rubber and the compounds in a solvent such as benzol toluol or naphtha making a pasty mass which is then applied to the cloth on spreading machines Shoe blacking is made in a similar manner

The workers who handle the rubber solution often develop dermatitis from dipping their hands in these solutions which contain not nly the rubber solvents but also accelerators or anti-oxidants In ne fact ry manufacturing rubberized cloth an outbreak of dermatitis ha been traced to the accelerator trieth l trimeth l triamine The rubber solvents dissolve the fat of the skin and tend to produce a dry fissured eczema Only a few workers however are affected

DERMATI NG THE USERS OF RUBBER GOODS

Dermatitis users of finished rubber goods has been reported Ob ed an outbreak of dermatitis of the hands

among linemen which he found to be due to an accelerator tetra-methyl-thiuram-disulphide, in the rubber gloves worn by the linesmen. (Fig 77) Schwartz, who investigated the manufacture of these gloves found that an excess of a number of accelerators and anti-oxidants were used in their manufacture resulting in a "bloom" after the gloves aged. Obermayer reported dermatitis from surgeons gloves which he showed to be due to products formed in the rubber by the action of the sulphur monochloride used to cure the rubber He found that washing the gloves in a 4 per cent solution of sodium hydroxide before using removed this irritating compound T E. Bailly stated that he found bathing the hands in a saturated solution of boric acid before and after wearing the rubber gloves helped to prevent dermatitis.

FIG. 77 —Lineman. Rubber glove dermatitis, due to tetra methyl thiuram disulphide (Case of Dr John Godwin Downing.)

Rattner reported dermatitis of the penis which was due to an acid cured condom. Following the suggestion of Obermayer he found that washing the condom in a 5 per cent solution of sodium hydroxide removed its irritating properties. Niles reported dermatitis from rubber bunion protectors. Adkinson and Walker reported dermatitis from an art gum eraser in which the patient was so sensitive that even coming into the room where the art gum eraser was used caused a slight eruption Halloran reported dermatitis of both hands and the posterolateral surfaces of the neck which he found was due to the rubber tips of a stethoscope Schwartz and Albaugh found that the dermatitis in a nut and bolt manufacturing plant among the workers who placed the nuts on the bolts was due to the reclaimed rubber used in the manufacture of the friction tape which the workers wrapped around the fingers to protect themselves against trauma. The authors have seen dermatitis of the axillae among women who

wore acid cured rubber dress shields to prevent staining of their dresses by perspiration. The rubber yielded positive patch tests.

Rubber is used in the manufacture of adhesive plaster. Schwartz and Peck have found South American Para rubber which contains the decomposition products of the combustion of the Uricuri nuts used in curing the latex to be one of the chief irritants in adhesive plaster.

Fig. 78. Dermatitis in clerk due to rubber finger cot. (Case of Dr. John Godwin Downing.)

Rubber itself is non-irritating to the skin. However, the various chemicals which are used to make it serviceable are often irritating to the skins of sensitive individuals. (Fig. 78). Whenever dermatitis is suspected to have been caused by rubber, patch tests should be performed with the rubber itself. The patch may be left on for forty-eight hours and if a positive reaction results, then further steps can be taken to discover the offending ingredients in the rubber. The rubber may be traced to the factory and information can be obtained concerning the accelerators, anti-oxidants and other compounds in the rubber. Patch tests with these substances usually reveal the irritant.

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CHAPTER XXXIV

DERMATOSES CAUSED BY SILK (NATURAL AND ARTIFICIAL)

SILK (NATURAL)

The female silk moth (*Bombyx mori*) lays about 40 000 eggs which hatch into larvæ of caterpillars. In this stage they immediately attack the edges of a mulberry leaf and eat voraciously so that in the course of six weeks they molt four times and grow to a length of about 3 inches. At this time they begin to spin their cocoons from which silk is derived

Silk is an excretion of the silk worm It is ejected from a tiny orifice in the worm s lower lip as a sticky substance called fibroin at about the time that the worm is ready to change into the chrysalis or pupa form The worm gradually envelops itself in the fibroin by a waving motion of its head and by a circular motion of its body until it is completely encased in the cocoon The threads composing the cocoon are glued together by a gum called sericin. After a period of from twenty to forty days the imago breaks out of the cocoon spreads its wings and becomes the moth The moth lives only a few hours just sufficient time to lay her eggs.

In Japan and Italy the silk worms are cultivated as are the mulberry trees to serve as food for the worms The silk worms themselves are kept in well ventilated houses which are weather proof and kept at an even temperature The silk worms are kept in trays on open shelves and they are protected from rats and birds. They are regularly fed green young dry mulberry leaves and when they are of sufficient size and ready to spin their cocoons, twigs and dry branches are provided for them

When the cocoons are formed they are collected and immersed in steam to kill the worm They are then sold by weight to manufacturers who reel the silk from them. If the moth is allowed to develop and emerge from the cocoon the silk of the cocoon is ruptured and it must then be spun in order to make a fiber The Chinese are said to reel silk from live cocoons and it is said that silk so reeled is of a finer quality than when the worm is killed by steaming

There are other kinds of silk besides the one described Tusser India, or wild silk is made from worms who feed on oak and other jungle trees. Such silk contains considerable tannin which must be first removed before the silk can be made into fine fabric Some Japanese silk is also made from oak-eating moths. The Antheraea Yama-Mai is the Japanese oak-feeding silk moth The Antheraea Pernyi is the Chinese oak-feeding silk moth In Central Africa the cocoons of the Anaphe moth are collected from the jungle and sent to the factory to be spun into silk.

The cocoons are first steeped in hot water and the outer or loose case is pushed away. The end of the silk forming the cocoon is found and attached to the reeling wheel. A number of these very fine threads must be reeled together in order to form one thread. The silk of six or eight cocoons go into the making of one thread. The hot water dissolves the sericin which sticks the threads together. A cocoon contains from 500 to 1,300 yards of silk.

Silk consists of fibroin sealed by a layer of sericin (a gummy substance), a little wax and coloring matter from the leaf on which the worm feeds. Silk, after being reeled from the cocoons, is of different colors: white, silvery, tan, brownish and yellow. It is rather coarse and hard, somewhat like horsehair.

Dermatitis of the hands of those who wind silk from the cocoons has long been known and described. Endo found that 14 per cent of the silk winders in Japan lost on an average of three days from work each year because of eczematous lesions on the fingers. It consists of a vesicular and pustular eruption of the hands and forearms which may develop into cellulitis and lymphangitis with constitutional symptoms. The cause of this condition has been attributed to the decomposition products of the dead chrysalis contained in the hot water in which the cocoons are immersed, and to a parasite which Vallin claims to be in the cocoon. Perutz, Taub and Sulzberger state that silk induces allergy of the skin, and that the silk protein is the allergen. They state that they have proved this by passive transfer.

Motov and Sardanowskaja state that the dermatoses found among silk reelers in Russia is mostly due to the hot water and the alkalis and mineral particles which it contains. Kartamischew found that a large percentage of the silk cookers and winders were afflicted with thinning and inflammation of the nails and partial onycholysis.

Dermatitis has been reported among cocoon handlers from African silk, and Carroll M. Salls states that this is due to the dust of the silk cocoons which contain barbed particles derived from the bodies of the silk worms. Gowdey states that the cocoons of the genus Anaphe, indigenous to Nigeria, contain hairs from the body of the larvæ which cause a painful urticarial inflammation. He states that soaking the cocoons before and after removing each envelope (there are three envelopes in a cocoon) lessens the danger of dermatitis from these hairs.

N. C. Foote states that there is a venom present in the spines which adds to their irritating effects. P. M. Gilmer states that while alkalis and heat temporarily inhibit the effects of the poisons contained in the hair, the virulence returns after an interval of from forty-eight to seventy-two hours, but that strong alkali or dilute potassium hydroxide completely destroys these irritating properties.

After the silk has been wound into a thread from the cocoons it must be further processed in order to be suitable for making into fabrics. This process is called silk throwing. The silk comes to the

thrower in skeins. The skeins are immersed in solutions of soap and oil to remove the sericin and wax still present. Dermatitis among silk throwsters has been reported by several observers

In one factory where a great many cases occurred the silk destined for weaving was immersed in a solution containing olive oil soap Neat's Foot oil and an anti-mildew solution consisting of 0.5 per cent cresol. The silk destined for knitting was immersed in a solution of sulphonated olive oil sulphonated cocoanut oil, potassium carbonate and an anti-mildew After coming out of this wetting solution the silk was dried in a centrifugal extractor and then hung up to dry After this it was wound and spun into threads of various thicknesses on spinning machines. The girls who handled

FIG 79 — Dermatitis on back of hands, where wet silk comes in contact. Due to hypersensitivity to soap and cresol used as wetting solution in which the silk is dipped before winding.

the wet silk (winders) were the ones who suffered from dermatitis. (Fig 79) This dermatitis consisted of an erythematous papular vesicular rash on the dorsum of the hands where the wet silk touched the skin as it was stretched out in the skein (See illustrations.)

Patch tests with the various ingredients of these wetting solutions showed that the strong soap solutions and the cresol anti-mildew were the irritants which combined with the friction of the thread on the back of the hands caused the dermatitis In factories where a minimum of soap and no anti-mildew were used there were no cases of dermatitis

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ARTIFICIAL SILK

This chapter is based on a study of 6 factories employing 10,000 workers. About 4,000 of these workers were actually examined for the occurrence of skin diseases and the sickness records in the plants were examined for the previous year

Manufacturing Process.—About 90 per cent of all the rayon manufactured in this country is viscose rayon. This is made from wood pulp or cotton linters which are bleached and pressed into sheets resembling blotting paper Cotton linters are the short hairs which remain attached to the cotton seed after the longer ones have been removed by ginning Wood pulp is the purified cellulose of the wood of the spruce or similar trees. The wood is cut into small pieces or "pulped" and then heated under pressure with a solution of calcium bisulphite containing sulphurous acid. This converts the lignin into a soluble calcium salt and dissolves other impurities. The residue is washed with water bleached with sodium hypochlorite again washed hydro-extracted pressed into sheets and dried The rayon factory receives them in this form The sheets are placed in a corrugating machine and then in a solution of 10 per cent of sodium hydroxide in which they are allowed to stand until they are thoroughly saturated with the alkali They are then pressed to squeeze out excess moisture and dumped into a shredding machine to be shredded to a bread crumb consistency They are then placed into containers and stored away for twenty-four hours to "ripen" in rooms where the temperature and humidity are under control.

Although workers at these processes wear rubber gloves and aprons burns from caustic are not infrequent and dermatitis also occasionally occurs among the men who work on the shredders where the most alkaline material is handled. In some factories a dilute solution of acetic acid is kept available in these departments so that workers can immediately apply it to neutralize splashes of alkali. Immediate immersion in water will also accomplish the purpose.

After ripening the shredded alkali cellulose is placed in large totally enclosed revolving steel drums where it is mixed with carbon bisulphide and revolved for some time. After the reaction takes place the drums are opened. Before opening they are exhausted of all carbon bisulphide fumes and the contents, cellulose xanthate a yellow colored solid substance taken out. The drums must be cleaned at regular intervals to remove material adhering to the sides. If the worker is careless and puts his head in the drum before it is entirely exhausted of all the carbon bisulphide he may develop carbon bisulphide poisoning. This is manifested by headache tremor defective gait and mental symptoms. The cellulose xanthate is dumped into large tanks containing a solution of about 3.5 per cent sodium hydrate and about 1 per cent sodium sulphite. This forms a thick yellowish jelly like liquid called viscose which is slowly passed through a series of tanks being filtered through muslin and absorbent cotton between each tank. It requires a number of days to pass through the series. The men working on the filters occasionally contract dermatitis from the alkaline viscose.

From the last tank of the series, viscose is forced through the spinnerette machines. These consist of a tube having at the end a perforated nozzle the number of holes varying from 10 to 60 or more according to the kind of thread desired. The nozzle is immersed in a coagulating bath consisting of about 10 per cent solution of sulphuric acid 20 per cent solution of sodium sulphate and about 0.5 of 1 per cent zinc sulphate. Sometimes a small amount of glucose and glue is also added to this bath. The alkaline viscose forced through the openings in the spinnerette is precipitated by the acid and forms a thread of white cellulose fiber which is lifted out of the bath and wound on bobbins. The workers on the spinnerette machines wear gloves and goggles but despite these precautions (Fig 80) they often suffer from burns of the hands and the forearms from the strongly alkaline viscose especially when the spinnerette is lifted out of the acid bath for changing spools. The acid bath itself may cause dermatitis by splashing and the acid spray or vapor arising from the bath may cause conjunctivitis. Vapors of hydrogen sulphide are also given off during this operation and may cause poisoning unless they are properly removed by ventilating processes.

The bobbins when full are placed on racks and are taken from the spinnerette machines to a room where they are washed with water to remove excess acid. The washing is continued until they are neutral to methyl orange as shown by a test. During this opera

tion carbon bisulphide is liberated and unless carried off by forced ventilation may cause symptoms of poisoning. After washing the bobbins are placed in de-sulphuring tanks. These may contain solutions of ammonium sulphide, sodium sulphide, sodium carbonate, sodium cyanide or sodium silicate. Dermatitis may occur from splashes of the de-sulphuring solution.

After de-sulphuring the bobbins are washed in water, dried and are then ready to be made into a thread by the twisting machines. After twisting they are either coned or wound onto reels.

FIG. 80.—Dermatitis on wrist of rayon spinner. Wears bandage around wrist and rubber gloves. Bandage is moist with solution of H_2SO_4, $ZnSO_4$ and Na_2SO_4.

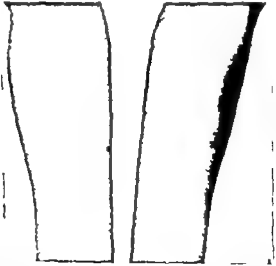

FIG. 81.—Dermatitis on arm of rayon inspectress. Due to coning oil.

In coning the silk, various oil mixtures are used to moisten the thread as it is wound on the cone. Sulphonated olive oil, sulphonated coconut oil, mineral oil, sperm oil, soya bean fat, or oleic acid mixed with solvents such as ethylene glycol, butyl ether and preservatives such as ortho-hydroxy-diphenyl, and sometimes a

deodorant such as oil of cloves is used to moisten the threads The girls who attend the coning machines must handle the threads moistened with these mixtures in order to unravel snarls to tie threads end to end and to keep the machines working properly As a result of this dermatitis of the hands and forearms as well as oil acne occasionally occurs among them from some of the ingredients of the coning oils (Fig 81) Some girls are immediately affected when newly employed at this work while others become sensitized after working for some time.

In one factory where the coners had dermatitis the oleic acid which constituted about 12 per cent of the oil was found to be the chief irritant. In another factory where oleic acid was not used in the coning oil the irritants were found to be oil of cloves and ortho-hydroxy-diphenyl

The rayon which is to be reeled is subjected to treatment with a solution containing soap bleach and oil The girls who inspect the wet reels occasionally develop dermatitis especially on the dorsa of the hands. This dermatitis is caused by injury of the skin in stretching and pulling the threads and the irritating action of the wetting fluid which is strongly alkaline and sometimes contains a disinfectant to prevent mildew

Bucket Spinning —In this process the rayon as it comes from the acid bath is twisted and wound in one operation into a bucket container This is done in such a manner that the outside of the cake as it is called is formed first and the inside last. When the bucket is full the cake is taken out and the bucket is replaced The operation of taking the cake out of the bucket is called doffing The doffer cuts the thread during this operation and lifts the spinnerette out of the acid bath During this operation he may receive a viscose or acid splash from which dermatitis may result

In one factory dermatitis among the doffers was found to be caused by the carbon bisulphide given off by the rayon in the acid bath The carbon bisulphide in the acid bath was sufficiently concentrated to penetrate the rubber gloves worn by the doffers and to cause dermatitis.

Staple Spinning —In this method, the nozzles or spinnerettes are coarser than those used to make rayon thread The products of a dozen nozzles are combined into a rope and wound into perforated aluminium cans After chemical treatment the same as for rayon thread the rope is cut into staple lengths varying from 1 inch to 2 feet The staples are picked dried and pressed into a bale.

Cellophane Manufacture —In this process the alkali viscose is forced through a narrow slot of required width into the coagulating bath and the cellulose comes out in the form of a sheet The sheet passes over rollers through a series of tanks containing washing de-sulphuring and bleaching solutions it is then dried and rolled at the end of the line Some of the rolls are waterproofed by applying varnish which may consist of a waterproof resin dissolved in a

solvent such as amyl acetate No dermatitis has been noted among any of the workers engaged in the manufacture of cellophane.

Cellulose Bands.—These are prepared from alkali viscose usually mixed with pigments such as titanium oxide ochre or iron oxide Ground mica is used for giving the material a metallic sheen and talc is used to make the substance opaque The bands are made by forcing the alkali viscose through a tube machine which is immersed in a coagulating bath consisting of a solution of $NaHSO_3$ and Na_2SO_4. This results in a partial coagulation necessary to prevent blister formation. During this operation sulphur dioxide and hydrogen sulphide arise from the coagulating trough and may cause irritation of the mucous membranes and poisoning of the exposed workers unless these gases are carried off by proper exhaust hoods. The tubes are passed and re-passed through the same solution until the coagulation is completed.

FIG. 82.—Dermatitis on hand of dyer of rayon due to chlorine in bleaching solution.

Cellulose Caps.—These are made by dipping glass tubes with the bottoms down, in a trough of alkaline viscose in such a manner as to coat them with a layer of viscose They are then immersed in a coagulating bath consisting of a solution of ammonium sulphate and sulphuric acid They are slowly moved through this bath which is contained in a long trough and are then washed in water to remove excess acid bleached in sodium hypochlorite solution washed again with water and colored with a direct dye (Fig 82.) The caps are then trimmed and cut to proper lengths. Girls who cut the wet caps sometimes develop a dermatitis on the part of the forearm which comes in contact with the edge of the table at which they sit This dermatitis is probably due to the friction of the table top against the wet skin These girls can be protected by a bland ointment (Fig 83) applied to the wrists and forearms and they should wear rubber sleeves fastened around the wrists

The cellulose caps are shipped to the consumer in a solution of formaldehyde parachlormetacresol or other preservative to preserve them. Dermatitis has been reported among workers who place the cellulose caps on bottles and it has been attributed to the formaldehyde and other preservative solutions in which the cellulose caps were shipped. Dermatitis among the handlers of such cellulose caps can be prevented by discarding the solution of preservative and replacing it with plain water before the workers are permitted to handle the caps.

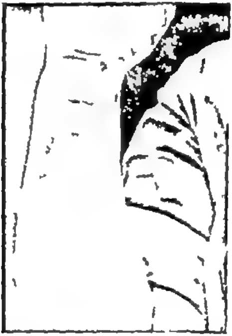

Fig. 84.—Dermatitis in rayon worker. Wet cellulose bottle caps.

Ester Silk.—The principal ester silk is cellulose acetate. There are practically no skin hazards in the actual manufacture of cellulose acetate. Whatever dermatitis occurs in the factory does so where the chemicals used in the manufacture of the silk are prepared.

This process starts with the making of acetylene from calcium carbide and water, and the finished products are acetic acid and acetic anhydride.

Mercury is used in the course of these operations and, unless properly protected, exposed workers may develop mercury poisoning. Burns, dermatitis and irritation of the mucous membranes may occur from irritating fumes of the intermediates as well as from the finished acetic acid and acetic anhydride unless proper precautions are taken for their disposal.

Cotton linters are used in the manufacture of cellulose acetate They are mixed with glacial acetic acid in large revolving drums in a process called "wetting the cotton." After revolving for some time acetic anhydride and 16 per cent solution of sulphuric acid are added A strongly acid and colorless jelly-like substance called "acetator gum" results. This is discharged into a tank called a "saponifier" where it is stirred until it saponifies. From this saponifier it is discharged into a tank of water which results in the precipitation of the cellulose acetate The contents of this tank are then filtered and the acetate cotton is repeatedly washed to free it from acid It is then pressed and dried The dried acetated cotton is dissolved in acetone forming a thick, white solution This is pumped through a series of filter presses to remove the impurities. After resting in large tanks, it is again filtered and pumped to the spinnerette machines. These consist of a nozzle perforated with many fine openings through which the solution is forced The filaments formed pass through a long heated tube where they are dried the acetone which evaporates from them being collected and re-used At the bottom of this tube the filaments go through a small opening where they are pressed together to form a thread The thread passes over a wheel wet with a solution of soap and sulphonated oil and is wound on a spool or bobbin The workers on the presses used to filter the solution of cellulose acetate in acetone are subjected to the vapors of acetone (in the enclosed heated rooms where the filters are located) and acetone "jags" consisting of dizziness and headache occasionally occur among them

Cellulose acetate in the form of sheets is used to make non-shatterable glass by being cemented between two panes of glass. Cellulose acetate is also put out in the form of small cubes which by heating and molding are made into plastics. It is also used in photographic film.

Nitro Silk.—Nitro silk, also called "chardonnet silk," is cellulose nitrate Cotton linters carefully scoured and bleached are used in making cellulose nitrate They are treated with a cold mixture of 1 part of nitric acid and 3 parts of sulphuric acid in sufficient water to make an 18 per cent solution This treatment takes place in a closed nitrating pot which is provided with an outlet for drawing off excess acid and another outlet for the escape of nitric fumes. Inhalation of these fumes may cause severe bronchitis and pneumonia the symptoms being manifested a few hours after exposure

The nitrocellulose formed in the nitrating pot is washed with water ("drowned") and freed of sulphuric esters of cellulose It is then hydro-extracted until it contains only 30 per cent of water and pressed into a cake. The pressed cake is dissolved in equal volumes of ether and alcohol filtered through cotton wool, or paper pulp and stored in storage tanks to "ripen." After ripening it may be dry-spun or spun in water Cellulose nitrate is highly inflammable but is rendered harmless and suitable for fabrics by denitration. This is done by immersing the reels of silk in a solution

of sodium hydrosulphide After this immersion it is washed soaped dried and bleached

Cuprammonium Silk.—Only cotton can be used to make this product It is manufactured by dissolving cotton in a solution of cuprammonium The cotton must first be highly purified and this is done by scouring and bleaching with a solution of sodium hypochlorite (NaOCl) and de-chlorinating with a solution of sodium thiosulphate The solution of cotton in cuprammonium is filtered and exposed to a vacuum to de-aerate it before it is ready for spinning It is spun into a solution of sodium hydrate containing glucose The thread is freed of copper by washing in dilute sulphuric acid and then in water The copper and the ammonia are recovered

According to P Cazeneuve A Morel and H L de Lecuw dermatitis burns and conjunctivitis occur in this method of artificial silk manufacture due to the ammonia fumes which are liberated when the thread is formed

Sizing and Finishing—When fabrics are woven from artificial silks, the threads are processed with a mixture containing an adhesive such as starch gelatin or casein a softening agent such as soap and a hygroscopic chemical such as glycerol. This process is called sizing and strengthens the threads Sulphonated soaps such as monopole soaps are used and a preservative such as phenol is included when starch and gelatin are used in the mixture Before woven and knitted goods are dyed they must be de-sized To do this an amylolytic enzyme is used although a 2 per cent solution of sodium perborate containing 3 per cent of soap can also be used for de-sizing and scouring if the material is boiled After scouring the goods are bleached with sodium hypochlorite After bleaching the goods are treated with a dilute solution of acetic acid They are again washed in water freed of chlorine in a bath of sodium thiosulphate and again washed in water

It is often desirable for selling purposes to give the goods a crinkle or scroop This is done by passing the rayon through a bath of 0 5 to 1 per cent soap solution hydro-extracting and then placing it in a bath containing formic lactic or tartaric acid. After this bath it is hydro-extracted and dried without washing "Scroop" may also be produced by immersing the goods in a solution containing tartaric acid gelatin and formalin.

Rayon is also weighted This is done by placing it in a solution of stannic chloride which hydrolizes upon washing with water and impregnates the rayon with precipitated stannic hydroxide After this the rayon is immersed in a bath of sodium phosphate or sodium silicate Sometimes the rayon is first treated with a solution of albumin to increase its affinity for the stannic chloride

Viscose rayon is sometimes weighted with lead by immersion in a solution of lead acetate and then in a solution of di-sodium phosphate to precipitate lead phosphate in the fabric

Barium sulphate and titanium oxide are also used for weighting

Dermatitis and burns occasionally occur from splashes of the irritating chemicals used in the weighting and spinning processes.

Rayon is often de-lustered by the addition of oil, wax or organic bases to the spinning solution

Rayon materials are also waterproofed by the use of such bodies as waxes aluminum soap aluminum sulphate casein and gelatin

Knitted goods such as hose are often given a finish by treating with a softening agent such as a sulphonated oil a soap or an oil emulsion.

Dermatitis is often reported among the wearers of artificial silk clothing These cases are always due to hypersensitivity of the patient to something in the rayon The many processes through which the rayon passes and the numerous chemicals with which it is treated increase the difficulty of determining the exact chemical in the fabric to which the patient is hypersensitive

PREVENTION OF DERMATITIS FROM ARTIFICIAL SILK

In that portion of the plant where chemicals such as zinc sulphate sodium sulphate, and other potential irritants are received and stored an effort should be made to prevent dust by dustless methods of unloading and by storing the chemicals in enclosed bins Methods should be devised to issue these chemicals without creating dust. The men who work in this part of the factory should be compelled to wear respirators while exposed to the dust to take shower baths after work, and to change to clean working clothes every day

In one factory studied where such precautions were not taken 12 workers exposed to the dust of these chemicals were examined and 4 were found to have ulceration of the nasal septum due to the inhalation of zinc sulphate dust.

In the rooms where the sodium hydrate the alkaline cellulose, the cellulose xanthate and the alkaline viscose are handled rubber gloves, rubber boots and rubber aprons should be worn by the workers. Water should be conveniently placed so that splashes of caustic can be quickly washed off

Workers in the spinnerette rooms especially in the viscose processes, should be compelled to wear rubber gloves reaching well above the elbow and goggles to prevent dermatitis burns and conjunctivitis from splashes of the alkaline viscose and from the acid and carbon bisulphide of the precipitating bath

The doffers in bucket spinning should also wear waterproof cellophane finger cots underneath the rubber gloves to protect them from carbon bisulphide blisters It has been found that the carbon bisulphide if sufficiently concentrated will penetrate rubber gloves but not waterproof cellophane

It is also advisable to have exhaust hoods over troughs of coagulating solutions to draw off irritating spray and gases

Rooms where such poisonous gases as hydrogen sulphide and carbon bisulphide are likely to collect as for example the room

where the shredded alkaline cellulose is treated with carbon bisulphide and the room with the wash racks on which the bobbins fresh from the spinnerette rooms are washed should not only be thoroughly ventilated with an exhaust but samples of air should be frequently examined to determine the concentration of these poisonous gases. It is also well to rotate crews of men on these jobs to prevent the cumulative effect of these poisons.

Workers on the coning and reeling machines who show hypersensitivity to the oils used should be placed at other jobs. Coning oils should be neutral and contain as few potential irritants as possible. Girls who work with wet reeled silk should have some protection on their hands to prevent dermatitis from the wetting solution as well as to prevent cuts from the threads of silk. Fingerless gloves worn over a skin smeared with a protective ointment have been successfully used for this purpose.

Workers on all processes such as sizing, weighting and finishing should wear protective clothing and should be instructed to remove immediately all splashes of the irritating chemicals by flushing with plenty of water.

Nylon.—Nylon is the trade name for a polymer of hexamethylenediamine adipate. The monomer is polymerized in totally enclosed kettles under high temperature and pressure and the aid of a catalyst. The polymer is extruded in ribbon form on a casting wheel. It is then broken up into flakes or chips. These are dropped on a heating grid which melts them into a thick viscid liquid. The thick hot liquid is forced through spinnerettes to form threads. The threads pass down a long cooled tube and are thus solidified. The individual fibers are twisted together to form a thread. Oil is used on them as they are twisted. The thread is oiled, twisted and stretched a number of times and covered with a sizing and wound on cones. The oils and sizing are removed at the factory where the nylon is made into fabrics. No cases of dermatitis have been reported in the manufacture of nylon.

An outbreak of dermatitis supposedly due to wearing nylon stockings was found to be actually due to a finish made from an ester gum.

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CHAPTER XXXI

DERMATOSES CAUSED BY ORGANIC SOLVENTS

Organic solvents are used to dissolve and thin varnishes, lacquers, and paints; to extract fats, waxes, oils, perfumes; as solvents for rubber, resins both natural and synthetic, sulphur, phosphorus; also as spot and dry cleaners. Solvents cause dermatitis: (1) By dissolving the keratin layer and then attacking the prickle cell layer causing erythema and vesiculation. (2) By dissolving and removing the sebaceous and fat content of the skin causing dryness and cracking. Thin, dry, senile skin is more likely to be thus affected than thick, oily, young skin. (3) Some of the solvents are allergens and cause allergic dermatitis in addition to primary irritation. Some solvents like hexane damage principally the epidermis. Others like benzol damage principally the cutis vera including the blood vessels. Those solvents which are readily absorbed through the skin cause the least severe dermatitis, but the most severe systemic symptoms. Those poorly absorbed cause more skin damage perhaps because they remain on the skin longer, and the least systemic symptoms. Or it may be that those which most quickly attack the skin cause severe acute dermatitis with exudation and outward flow of serum and therefore are not readily absorbed. Solvents which evaporate quickly cause comparatively little damage to the skin if they are not sealed on or kept on by wet clothes or fabrics.

All solvents can cause chronic fissured eczemas if the skin comes in contact with them frequently as when they are used for washing grease from the hands, or when solvent moistened cloths are held in the hand for cleaning or degreasing operations.

The saturated hydrocarbon solvents and the paraffin series of solvents are stronger skin irritants than those derived from the aromatic series. The high boiling fractions are more severe irritants than the low boiling fractions.

Dermatitis among workers who manufacture solvents is infrequent because the processes are usually totally enclosed. Dermatitis among the users of solvents is of frequent occurrence but is not so frequently recognized and reported.

PETROLEUM SOLVENTS

Petroleum ether, mixed hydrocarbons	B.P. 40°–70° C.
Gasoline, mixed hydrocarbons	B.P. 70°–80° C.
Benzine, mixed hydrocarbons	B.P. 80°–100° C.
Ligroin, mixed hydrocarbons	B.P. 100°–120° C.
Petroline, mixed hydrocarbons	B.P. 120°–150° C.
White spirit, mixed hydrocarbons	B.P. 150°–210° C.
Stoddard solvent, mixed hydrocarbons, Varsol	B.P. 300°–400° C.

Among the petroleum solvents dermatitis has been frequently reported from benzine among (1) plate printers who clean inks from the presses with cloths soaked in benzine (2) among dry cleaners who handle cloths damp with benzine to remove stains from fabrics.

Gasoline has been reported to have caused dermatitis among plate printers, dry cleaners truck drivers and gasoline pumpers. Butane gas and ethyl gasoline have also been reported to have caused dermatitis. Stoddard solvent used as a degreaser of metal parts and a fabric cleaner is a frequent cause of dermatitis as is Varsol used for the same purposes. Stoddard solvent was reported to have caused subacute yellow atrophy of the liver in a man using it two weeks for dry cleaning Dermatitis from these solvents usually occurs on the fingers the interdigital spaces, the hands and forearms. It may be acute erythematous papular or vesicular It may be a chronic scaling cracking type of eczema. All of them are the result of primary irritation although thin dry senile skins are more sensitive than others. (Figs. 84 and 85)

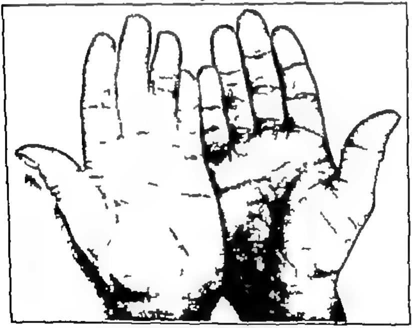

FIG. 84.—Petroleum solvent dermatitis.

Workers should not be permitted to immerse the hands in solvents when doing degreasing operations. Solvent proof rubber gauntlets under solvent proof sleeves closed at the wrist should be worn. Long handled mops or brushes can be used in some operations. If it is impractical to wear protective clothing, then solvent resisting ointments offer some protection. They should

be of the type that leave a dry solvent repellent film on the skin. They should be reapplied two or three times during a shift, washing and drying the hands and arms thoroughly before each new application. After the work is over workers should use an emollient cream on their hands. This can be applied at night. Its basic ingredient should be lanolin (70) castor oil (30). Workers who have their hands immersed or wet with these solvents should cleanse their hands with a vegetable oil cleanser such as sulphonated castor oil to which about 5 to 10 per cent of unsulphonated castor oil is added in order to avoid more defatting of the skin with ordinary soaps.

FIG. 85.—Occupational dermatitis due to benzene. (Collection of Dr. Howard Fox.)

If the fumes of the petroleum solvents are inhaled they may cause headache, nausea, vomiting and other symptoms of systemic poisoning.

COAL TAR SOLVENTS

Cyclohexane—C_6H_{12}	B.P. 80–81° C.
Toluol—$C_6H_5CH_3$	B.P. 110.7° C.
Benzol—C_6H_6	B.P. 130° C.
Xylol—$C_6H_4(CH_3)_2$	B.P. 144° C.
Light solvent naphtha	B.P. below 100° C.
Heavy solvent naphtha	B.P. 100–100° C.
Tetrahydronaphthalene—$C_{10}H_{12}$	Paints, varnishes, shoe creams, floor waxes
Decahydronaphthalene—$C_{10}H_{18}$	
Hexahydrophenol—$C_6H_{11}OH$	Disinfectant, germicide, deodorant, used in fish oils, cutting oils, wood preserving

Among the coal tar solvents dermatitis has been reported from benzol, toluol, xylol, solvent naphtha, and tetralin. All of them have been reported to have caused systemic poisoning.

1. *Coal tar naphtha* which is a complex product containing naphthalenes, phenols pyridine aniline toluidine thiophens, and other sulphur compounds. It is a rather foul-smelling liquid which is refined by treating first with sulphuric acid to remove the unsaturated fatty hydrocarbons the high benzene hydrocarbons and thiophens, and then with caustic soda to remove the phenols. Coal tar naphtha is used as a solvent for pitch and is distilled to obtain other fractions.

2. *Benzol* is the fraction which comes over below 130° C. This product is not pure benzene (C_6H_6). It consists chiefly of benzene and toluene with a small amount of light hydrocarbons and carbon disulphide. It is used as a solvent for rubber resins oil-soluble dyes in paint removers in the manufacture of nitrobenzene and synthetic indigo and in turpentine substitutes. It is probably the most poisonous of the coal tar solvents and therefore its use has been curtailed and less poisonous compounds substituted. It can produce dermatitis by its fat-solvent action on the skin.

Occupational eczema among printers who used benzol as a cleaning fluid was reported by Zitzke. Londi and Kalmowsky reported a case of chronic benzol poisoning in which the first symptom was contact dermatitis of the upper extremities. Toegel reported an inflammation of the fingertips with onycholysis in a truck driver which he attributed to benzol used to clean the truck.

3. *Light solvent naphtha* comes over between 130° and 160° C. It is used as a rubber solvent to replace the more toxic benzol.

4. *Heavy solvent naphtha* comes over between 160° and 190° C. It is used as a thinner and solvent in paints, varnishes and lacquers. It is germicidal destroying molds and insects on wood and is therefore used in wood preservatives. It is a fat solvent and can produce dermatitis.

5. *Toluol or Toluene* (C_7H_8) is obtained from coal tar naphtha by fractional distillation. It is used as a rubber solvent in the rubber adhesive industry. It is also used in the manufacture of explosives such as trinitrotoluol (TNT) and in the manufacture of synthetic dyes and perfumes.

6. *Xylol or Xylene* (C_8H_{10}) is used as a solvent for asphalt and in the printing industry.

7. *Tetralin* ($C_{10}H_{12}$) is prepared by the action of hydrogen on naphthalene. It is a solvent for oils resins and rubber and is also used in turpentine substitutes. It is said to be toxic to insects but not to humans. E. Calewski, however, records dermatitis from the use of tetralin and dekalin and Arnstein reports systemic poisoning from its use.

8. *Dekalin* ($C_{10}H_{18}$) is prepared by further hydrogenation of tetralin and is used for the same purposes.

Systemic poisoning from benzol toluol and coal tar solvents usually occurs by inhalation but may also occur through skin absorption. Inhalation of small quantities causes headache giddiness and vomiting followed by recovery. If larger quantities are

inhaled trembling excitement, convulsions, delirium and coma may follow. Chronic poisoning manifests itself by nervous symptoms, weakness, indefinite gastro-intestinal symptoms, cramps, bleeding from the mucous membranes and aplastic anemia.

CHLOROHYDROCARBON SOLVENTS

Methylene chloride—CH_2Cl_2	B.P. 42 C
Dichlorethylene—$C_2H_2Cl_2$	B.P. 48.4 C
Ethylene dichloride—$CH_2Cl.C_2H_2Cl$	B.P. 55 C
Chloroform—$CHCl_3$	B.P. 61 C
Ethylene trichloride—$CH_3C\,Cl_3$	B.P. 74.5 C
Carbon tetrachloride—CCl_4	B.P. 77 C
Trichlorethylene—$C_2H\,Cl_3$	B.P. 86.7 C
Epichlorhydrin (sapon solvent)—C_3H_5OCl	B.P. 117 C
Perchlorethylene—C_2Cl_4	B.P. 119 C
Ethylene chlorhydrin—$(CH_2)_2ClOH$	B.P. 128 C
Monochlorbenzene—C_6H_5Cl	B.P. 132 C
Tetrachlorethane—$C_2H_2Cl_4$	B.P. 146.3 C
Pentachlorethane—$C_2H\,Cl_5$	B.P. 160 C
Dichlorbenzene—C_6H_4Cl	B.P. 174 C
Dichlorhydrin—$C_3H_5Cl_2OH$	B.P. 178 C
Dichlorethyl ether—$(CH_2)_4Cl_2O$	B.P. 178 C
Hexachlorethane—C_2Cl_6	B.P. 18. C

While all of the chlorohydrocarbon solvents can cause dermatitis by primary irritation some also are sensitizers and cause allergic dermatitis. Trichlorethylene, ethylene dichloride and carbon tetrachloride have been reported as causing generalized allergic dermatitis. Systemic poisoning has been reported from trichlorethylene, carbon tetrachloride and ethylene-dichloride. When inhaled they cause liver damage, jaundice, nervous and psychic symptoms.

Ethylenedichloride is used as a solvent for the synthetic waxes and in mixtures with carbon tetrachloride has caused generalized allergic dermatitis. (Fig. 86.)

Carbon tetrachloride is used in the dry cleaning industry and dermatitis as well as systemic poisoning has been reported caused by it where there was exposure to its vapors or actual skin contact. It causes dermatitis on prolonged contact and if concentrations of 100 parts per 1,000,000 are breathed it causes headache, nausea, *gastro-intestinal irritation, jaundice and visual disturbances.* Carbon tetrachloride is often added to petroleum and coal tar solvents to reduce the fire hazard. It is also used as a rubber solvent. Carbon tetrachloride should be used as a solvent, cleaner or degreaser in closed systems. It should not be kept in open cans on work tables.

Trichlorethylene dissolves oils, resins, sulphur and phosphorus. It is most frequently used to degrease metal parts but is also used in mixtures with other solvents to clean fabrics. It is a primary irritant (Fig. 87) and a sensitizer as well as a protoplasmic poison although it has been recommended as an efficient wound cleaner.

Perchlorethylene is used for similar purposes. When used for degreasing it should be kept in covered tanks which are cooled about 1 foot below the top in order to prevent escape of vapors. The lid should only be opened when parts are put into or taken out of the tank. When the lid is open workers should be careful not to stay longer than necessary near the tank, as vapors arise from the parts as they are taken out. The workers should wear gloves, sleeves and aprons made of polyvinyl alcohol in order to prevent contact with the skin. Rubber gloves are penetrated by the chlorohydrocarbon solvents. Tetrachlorethane is sometimes used in dry cleaning mixtures and because it is a heavy liquid with a high boiling point traces of it may remain in the cleaned clothes and cause dermatitis on the wearer. It is toxic as well as a skin irritant. It is a good solvent of pitch, oil, resins, waxes, cellulose nitrate and acetate.

FIG. 96.—Dermatitis in worker with chloronaphthalenes. Patch tests with the solid chloronaphthalenes are negative. The dermatitis was due to the fumes of the solvents used in dissolving the chloronaphthalenes, di-ethylene chloride and carbon tetrachloride.

Mono- and dichlorbenzene are also toxic and skin irritants.

Epichlorhydrin is the solvent contained in Zapon and is probably the actual cause of the dermatitis reported as caused by Zapon.

Workers with all the chlorohydrocarbon solvents should take the precautions described under trichlorethylene.

ALCOHOL SOLVENTS

Methyl alcohol—CH_3OH
Ethyl alcohol—C_2H_5OH
Propyl alcohol—C_3H_7OH
Isopropyl alcohol—C_3H_7OH
Butyl alcohol—C_4H_9OH
Secondary butyl alcohol—C_4H_9OH
Tertiary butyl alcohol—C_4H_9OH
Amyl alcohol—$C_5H_{11}OH$ (used in fruit essences and perfumes)
Isoamyl alcohol—$C_5H_{11}OH$
Secondary amyl alcohol—$C_5H_{11}OH$
Tertiary amyl alcohol—$C_5H_{11}OH$
Cyclohexanol—$C_6H_{11}OH$
Benzyl alcohol—$C_6H_5CH_2OH$ (used in perfumes)
Capryl alcohol—$C_8H_{17}OH$ (antifoam agent)
Decyl alcohol—$C_{10}H_{21}OH$ (antifoam agent)
Allyl alcohol—CH_2CHCH_2OH (powerful skin irritant, used in making allyl resins)

Ethyl alcohol is obtained from fermentation of cereals and sugar and also synthetically from calcium carbide. It is denatured for commercial use by the addition of pyridine, acetone, naphtha, diethylphthalate and other noxious substances.

Ethyl alcohol has not been reported to have caused contact dermatitis. But the author has seen occupational contact dermatitis among girls washing old mica sheets with ethyl alcohol. Dilatation of the small blood-vessels of the face has been observed among workers who treat nitrated cotton with alcohol and ether where they breathe considerable quantities of the vapors. Dermatitis may also be caused by denaturants used in ethyl alcohol. Baer and Mumford have reported such cases. Strean has reported angioneurotic edema from drinking alcohol and it is known that after drinking alcoholic liquors flushing of the face and wrists and sometimes swelling of the lips, tongue and oral mucous membranes occurs among workers with tetramethyl thiuram disulphide, tetramethylthiuram monosulphide, carbon bisulphide and calcium cyanamid.

Methyl alcohol is a by-product in the manufacture of acetic acid from wood. It can also be made synthetically by combining hydrogen and carbon monoxide under heat and pressure in the presence of a catalyst. It is a systemic poison attacking the optic nerve causing blindness and death. It can also cause dermatitis.

Allyl alcohol is used principally in making the allyl resins and for modifying alkyd resins. It is a powerful primary irritant and sensitizer. (See Resins.)

The higher alcohols, propyl, butyl, amyl, benzyl, etc., are used as commercial solvents and may cause dermatitis.

ESTER SOLVENTS

Methyl acetate—$C_3H_6O_2$
Ethyl acetate—$C_4H_8O_2$ + CH
Butyl acetate
Amyl acetate
Methyl formate—$C_2H_4O_2$
Ethyl formate—$C_3H_6O_2$ + CH (insecticide)
Butyl formate
Amyl formate (perfuming leather)

The ester solvents are used in paints, varnishes and airplane dopes. While they are usually used in vented spray paint booths dermatitis of the face occasionally occurs from exposure to the mists. Workers on spray paint booths should be careful to spray toward the exhaust and not against it

ETHYLENE GLYCOL SOLVENTS

Ethylene glycol monomethyl ether (methyl cellosolve)—B P 124.3 C
Ethylene glycol monoethyl ether (cellosolve)—B.P 135 1 C
Ethylene glycol monoethyl ether acetate (cellosolve acetate)—B.P 156 2 C
Ethylene glycol monobutyl ether (butyl cellosolve)—B.P 170.6 C
Diethylene glycol monoethyl ether (carbitol)
Diethylene glycol monobutyl ether (butyl carbitol)
Diethylene glycol monomethyl ether (methyl carbitol)

This group of solvents are not frequent causes of dermatitis. Diethylene glycol used as a hygroscopic agent in one brand of cigarettes has been reported by Newman to have caused dermatitis on the fingers and lip The cellosolves have caused dermatitis among rayon winders where they were used in the "coning oil" Ethylene glycol and diethylene glycol have been reported to have caused systemic poisoning when taken internally There have been no cases of dermatitis reported from the Carbitols. Carpenter and Crunch say they are no more toxic than glycerine or cetyl alcohol

KETONE SOLVENTS

Acetone—$CH_3CO\ CH$
Methyl acetone is a mixture of acetone methyl acetate and methyl alcohol
Methyl ethyl ketone $CH_3CO\ C\ H$
Methyl cyclo hexanone—$CH_3C_6H_9O$
Methyl cyclo hexane—C H

Dermatitis has not been reported from the ketone solvents but the authors have seen occupational dermatitis from methyl ethyl ketone

NITROPARAFFIN SOLVENTS

Nitro-methane CH_3NO_2
Nitro-ethane—$CH\ CH\ NO_2$
Nitro-propane $CH\ (CH\ )\ NO_2$

Made by nitration of petroleum hydrocarbons and used chiefly as solvents for resins. There are no reported cases of dermatitis from the nitroparaffin solvents.

MISCELLANEOUS SOLVENTS

Carbon bisulfide—CS_2—B.P. 42.25° C.
1.4 Diethylene oxide—$(CH_2)_4O_2$ (dioxane)—B.P. 101° C.
Polysolvan O
Hydroterpin
Sangajol (mixture of benzol, xylol, toluol, paraffin)

Carbon bisulphide is a clear inflammable liquid made by passing sulphur vapor over red hot carbon. It is used as a solvent for sulphur chloride in the curing of rubber, to make cellulose xanthate in viscose rayon manufacture, to extract fat from bones and from animal and vegetable wastes, as an insecticide and vermin killer. It is a primary skin irritant and Heuper has reported dermatitis from it among rayon spinners where it penetrated rubber gloves. Inhalation of the fumes causes peripheral neuritis, staggering gait, paralysis, mania and sometimes insanity.

In the German literature, dermatitis has been reported from "Sangajol," a mixture of benzene, xylene, toluene and paraffin. Also from Polysolvan O, a varnish solvent and from Hydroterpin, a lacquer thinner.

PREVENTION OF DERMATITIS FROM ORGANIC SOLVENTS

The volatile solvents should be manufactured by totally enclosed processes. When used, they should be enclosed as much as possible and open tanks should be vented to prevent the diffusion of the fumes. In the placing of suction vents, the heaviness of the solvent vapors must be considered.

The practice among workers of cleaning their hands by washing them in irritant solvents should be prohibited.

If any of the liquid spills on the clothes, they should be removed immediately and changed.

Aprons of oil cloth often prevent soiling of work clothes.

Periodic examinations of the air should be made to determine the concentrations of the poisonous vapors.

Leaks in defective apparatus which contain irritant solvents should be detected and repaired.

Periodic examination of exposed workers for early signs of chronic poisoning should be made.

TURPENTINE SOLVENTS GROUP

The composition of these vary but they consist mainly of dextro and levo pinenes.

Turpentine—$C_{10}H_{16}$	Spike oil (perfume)
Wood spirit	Terpineol
Pine oil	Rosin spirit
Pine needle oil (perfume)	Tar spirit

Turpentine is mainly derived from the resinous exudation of various species of pine and other coniferæ. It is also obtained as a by-product in the manufacture of sulphate pulp for paper. In France turpentine is obtained from the *Pinus maritima*, in India from the *Pinus longifolia*, the *Pinus excelsa*, and the *Pinus Khasya*, in Greece from *Pinus halepensis*, in Russia from the *Pinus sylvestres* and in America from the longleaf pine, *Pinus palustris*, which grows abundantly in the Southern Atlantic States, *e. g.*, Virginia, the Carolinas, and Georgia.

Gum turpentine is obtained by tapping the pine tree and collecting the oleoresin which flows from the wound into galvanized iron or clay receptacles. Trees 9 inches in diameter and about fifteen years old are first tapped near the ground. The oleoresin from this first cut is exhausted in about a week or two and another cut is made a few inches above it, so that in one year the tree is worked on one side to a height of 3 feet. The same side is worked for three years up to a height of 9 feet and then the other side is worked in a similar manner. At the end of this time the tree is still usable as lumber. The oleoresin is regularly collected and distilled in closed kettles, the turpentine coming off and the rosin remaining.

There is no particular skin hazard connected with the collection and distillation of Pine Gum Dip. Occasionally a collector in the forest may develop dermatitis from the chigger (Rhinochorprian penetrans) or sand flea. The female chigger burrows into the skin to hatch her eggs. The skin of the feet or legs is usually affected and the parasite can be recovered from the burrows.

Russian turpentine is made by the destructive distillation of wood and is characterized by an extremely pungent and unpleasant odor.

Steam-distilled turpentine is made in large quantities from pine tree stumps. These are cut into shreds, mixed with a petroleum solvent, and distilled under pressure. The spent dry wood which remains is used as fuel. The petroleum solvent is fractionally evaporated and the liquid remaining is further distilled, leaving behind wood rosin. Wood turpentine is distilled from this liquid leaving behind pine oil.

Gum turpentine is water white when fresh and pure and consists almost entirely of dextro-pinene and levo-pinene. The proportions of these vary in the gum turpentine from different countries. Russian turpentine also contains a large percentage of sylvestrene. American steam-distilled turpentine consists of from 70 to 90 per cent of alpha and beta pinene, about 10 per cent of dipentene, a special lacquer solvent, and a small amount of paramenthane or parathinner ($C_{10}H_{20}$). All turpentines darken on standing. This is said to be due to oxidation of the resin content.

Pine oil consists of a mixture of higher alcohols. The major constituent of pine oil is alpha terpineol ($C_{10}H_{17}OH$) to the extent of about 60 per cent. Borneol constitutes about 12 per cent. It is used in the manufacture of synthetic camphor. Pine oil is said to have the power of penetrating the skin and acting as a fungicide.

It is used as a slow drying solvent Fenchyl alcohol makes up about 8 per cent of pine oil. It is used in the manufacture of essential oils and is highly antiseptic. Other substances in pine oil are camphor estragol and phenol

Turpentine from any source is a skin irritant and will cause dermatitis if allowed to remain on normal skin some length of time It causes about 1 per cent of reported cases of occupational dermatitis McCord states that the destructively distilled wood turpentine before it is oxidized is the least irritating next follow gum spirit and medicinal turpentine with steam-distilled turpentine the most irritating He states that wood turpentine which is not well fractionated may contain small quantities of formic acid methyl alcohol formaldehyde acetaldehyde acetone acrolein methylamine furfuraldehyde phenols benzene, pyridine isoprene, methyl ethyl ketone and methyl acetate

In a modern factory inspected by the authors which prepares steam-distilled turpentine and where about 500 men are employed there occurred only 2 cases of dermatitis due to pine products. The manufacturing process was totally enclosed and kettles were under suction to prevent contact with the chemicals.

Patch tests were performed on 10 volunteer workers with pure pine oil pure alpha terpineol pure fenchyl alcohol 15 per cent borneol in lanolin pure terpinyl methyl ether pure furfural pure dipentene pure paramenthane and 30 per cent abietic acid in olive oil After twenty-four hours there were no reactions to pine oil borneol terpinyl methyl ether furfural or abietic acid One man reacted to alpha terpineol and fenchyl alcohol All the men gave marked reactions (actual vesication) to pinene dipentene and paramenthane and most severe reactions were obtained from dipentene

Henry F Smyth in an unpublished communication to the authors, stated that he examined 572 spray painters and found 12 cases of dermatitis Only 3 of these were due to turpentine used to clean the hands He quoted Sir Thomas Legge who reported 31 cases of dermatitis attributable to turpentine or its substitutes in Great Britain in 1925. Only 5 were due to steam-distilled turpentine 7 to turpentine substitutes, and 19 to materials not definitely described He also quoted Dr Legge's report of an outbreak of dermatitis in a plant which used American steam-distilled turpentine and where 12 per cent of 132 workers exposed were affected Smyth performed experiments on guinea pigs and human beings by allowing turpentine to drip on the skin drop by drop for an hour or less until irritation appeared he also applied to the skin a piece of gauze saturated with turpentine for an hour or less He stated that after ten to twenty minutes a tingling or burning was felt which lasted as long as two hours if the application of turpentine was immediately removed An area of hyperemia developed around and under the pad Upon removal of the pad or drip the skin area dried with a whitish bloom After twenty four hours the reaction disappeared or the erythema persisted and the skin became rough

or vesication resulted and was followed in a few days by peeling. If the blisters did not appear the skin might become dry and thickened with a tendency to crack and a slight pigmentation developed which lasted for weeks. He found that steam-distilled turpentine was more irritating than gum spirits and that destructively distilled turpentine was least irritating.

In a series of tests to determine the irritating fractions of steam-distilled turpentine Smyth found the following irritating in diminishing order:

Para menthane	Furfural
Dipentene	Cineol
Para cymene	Fenchyl alcohol
Alpha pinene	Pine oil

The fraction with the most irritating properties showed the largest percentage of polymerization residue.

Smyth concluded that steam-distilled turpentine was not excessively irritating despite its increased use. He advocates a preventive ointment of equal parts of tragacanth mucilage and lanolin which is easily removed with soap and water. This affords some protection to normal persons but not to the hypersensitive. Smyth also advocates the inunction of lanolin or oil after work to replace the skin fat dissolved by the turpentine. Gloves are not suitable for protection because the turpentine gets inside.

Danbolt and Burckhardt, in a series of experiments found that pinene was the most irritant substance in turpentine.

Burckhardt and Schaaf also found that pinene was the principal irritant in turpentine and that a 10 per cent dilution will give a positive patch test reaction in hypersensitive individuals, but they found some cases of turpentine eczema who reacted to dilutions of 1 part to 100,000. They found that old turpentine is more toxic than fresh turpentine.

Turpentine has an odor (due to an aldehyde) which makes some people ill, but does not affect others. Turpentine when allowed to stand for a while especially if it is exposed to light, changes from a watery to a straw yellow color and increases in acidity and in irritating properties. This change is said to be due to oxidation which results in the formation of limonene formic acid aldehydes and an increase of dipentene.

Although turpentines from various sources differ in composition there is little doubt that turpentine from any source is a skin irritant for normal individuals if allowed to remain on the skin a sufficient length of time. Some people are so hypersensitive that even a moderate exposure to the fumes will cause a skin reaction.

Local contact of the skin with turpentine for a long time, or often repeated exerts an irritating and a drying effect on the skin causing it to crack and sometimes an active dermatitis will develop.

Hydroterpin is a turpentine substitute used as a solvent for lacquer and consists of hydrated pine oil obtained from German forests.

It has been reported by Zitzke as the cause of 12 out of 14 cases of dermatitis in a lacquering shop

Terpineol is a liquid with an odor resembling lilac and is used as a solvent for hard resins such as Kauri Manila and Copal

Resin spirit obtained by the destructive distillation of resin is a good solvent for oils.

Tar spirit is obtained by redistilling the crude tar left by the destructive distillation of wood It is of complex composition and contains terpenes creosote acetone and phenols

Pine needle oil is obtained from the needle-like leaves of the pine by steam distillation. It consists of a mixture of terpenes principally limonene sylvestrene phellandrene dipentene and pinene It has an agreeable odor and is used as a deodorant in other solvents

Prevention.—Most people are not so highly susceptible to turpentine as to develop a dermatitis from ordinary exposure to it. Even when used to clean the hands after work, comparatively few painters develop dermatitis providing soap and water are used afterwards. However there are some extremely hypersensitive persons and the hypersensitivity may be acquired after many years of handling turpentine safely Such persons should not come in contact with it Moderately susceptible individuals can obtain protection by the use of long rubber gloves which reach to the elbow and are so arranged that the sleeves of the shirt or coat cover the ends of the gloves and are tied at the wrist to prevent the turpentine from entering the gloves

Equal parts of tragacanth mucilage and lanolin are recommended as a protective salve by Smyth and equal parts of olive oil and beeswax by the National Safety Council These ointments should be removed thoroughly with soap and water at the end of the work day and a bland fat or oil such as lanolin olive oil or cocoa butter should be rubbed into the skin

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CHAPTER XXXVI

SUGAR INDUSTRY

SUGAR is produced principally from (1) the sugar cane which belongs to the family of grasses (*Gramineae*) and (2) from the sugar beet, a descendant of the wild beet (*Beta maritima*). Sugar is also produced in small quantities from (3) Sorghum cane or sugar grass (*Sorghum saccharatum*) which belongs to the same botanical family as sugar cane and which matures (in about three months) in much less time than the sugar cane but yields a lower amount of sugar per acre. (4) Maize or Indian corn (*Zea mays*) which also belongs to the sugar cane family. The sugar is obtained from the stem. (5) The sugar maple (*Acer saccharinum*) which is tapped in the spring and yields sap for about three weeks. The sap is collected and the maple sugar extracted. (6) The sugar palms: (a) coco-nut palm (*Cocos nucifera*), (b) Date palm (*Phœnix sylvestris*), (c) Nipa palm (*Nipa fruticans*), (d) Aren palm (*Arenga saccharifera*), (e) Sugar palm of Ceylon (*Caryota urens*), and (f) Palmyra palm (*Borassus flabelli-formis*) which grows in India.

The sugar palms, except the date palm, are tapped at the flower stalk and the sap is collected in bamboo tubes. The date palm is tapped at the top of the stem about 60 feet above the ground and the sap is collected through a bamboo tube in an earthenware container.

BEET SUGAR

In the year 1747, Marggraf, a German chemist, discovered that the Silesian beet contained from 5 to 7 per cent of sugar. In 1799 the first sugar factory was built in Germany. Since then, the present sugar beet has been developed and the sugar content increased above that of the sugar cane, some beets containing as much as 20 per cent of sugar.

The cultivation of sugar beets, as well as the seed production, is an art because the present beet is an artificial plant and tends to revert to its natural low sugar content type. It grows in temperate climates and the crops are harvested from early Autumn to late in November. Beet sugar factories work at high pressure during the short season or "campaign," and then close down until the new crop arrives.

The beets received at the refinery are washed with water in a washing machine. Sometimes the water used for washing is used over and over again and a strong odor of hydrogen sulphide develops over the washing machines, causing conjunctivitis and a health hazard to the workers.

After washing, the beets are sliced into small pieces which are fed into a series of iron cylinders called a "battery," and treated with hot water, the sugar being dissolved by a process called "diffusion."

The juice leaving the diffusion battery contains foreign matter which is eliminated by treatment with lime and then precipitation of the lime with carbon dioxide. This process is called defecation. The lime and the carbonic dioxide are prepared in the sugar factory and dermatitis and lime burns occasionally occur among workers at this operation. (See Alkalis.)

The solution of sugar is then passed through filter presses and the juice clarified with sulphur dioxide or by passage through animal charcoal. It is then concentrated to a syrup by evaporation and under a vacuum until the sugar crystallizes out. The sugar is then emptied into centrifugals to be washed and dried. The brown sugar and the beet syrup are sold as cattle feed.

Morbidity is high in beet sugar factories because the work is seasonal and carried on at high pressure in rooms where the temperature and humidity are high. Among workers in beet sugar factories dermatoses are common. They consist chiefly of furunculosis and inflammation of the uncovered parts of the body, the fingers, nail folds, hands, forearms, and neck.

The hot syrup enters cracks and abrasions in the skin and causes serous exudation. Secondary pyogenic infections may occur. The clothing may become saturated with syrup and affect the skin. When the dry viscous masses of sugar are forcibly removed from the skin, the hairs are pulled out and this may result in such secondary infections as folliculitis, boils, and lymphangitis. These conditions are more marked in the factories where the raw brown sugar is produced and are not frequently seen in the refineries. In 2 refineries in Great Britain employing 4,000 workers, only 12 cases of lymphangitis have been noted in five years, and from 1928 to 1930 there have been 187 cases of dermatitis attributed to sugar reported in all of Great Britain, of which only 37 have occurred among sugar refiners and 93 among confectioners.

CANE SUGAR

The sugar cane belongs to the botanical family of grasses (*Gramineae*) which includes wheat, corn, maize, etc. It is said to have been first cultivated in India, from where it spread to China and Arabia and by the Arabs introduced to Madeira in the year 1420 (The Manufacture of Sugar from the Cane and Beet, by T. H. P. Heriot). Today it is cultivated wherever there is suitable climate and soil. There are several natural and hybrid varieties of sugar cane. The plant may attain a height of 20 feet.

Sugar cane is planted by cutting the stalk of the cane into sections and planting those which contain the joints. It takes from eighteen to twenty-four months for the cane to mature and the planting is done so that the crop is continuous. Sugar cane growing depletes the soil and fertilizers such as nitrates, phosphates, lime, and animal products are extensively used. On modern plantations the ploughing, planting, and fertilizing are done by machine.

When the cane is ripe and the top leaves are dry a fire is started Only the dry top leaves burn the green sappy stalk remaining unharmed. The cane is then cut near the root by hand the tops which contain no sugar are cut off and the stalks loaded into wagons and sent to the mill. In some modern plantations mechanical harvesters do this work

In the mill the cane is passed through a machine which cuts it up into small pieces but extracts no juice The pieces then go through a shredder where they are torn into strips but no juice is extracted The strips then go through the crushers a series of metal rollers and the crushed fiber is saturated with water to dissolve whatever sugar remains in the cells of the cane The next crusher squeezes out this solution and the process continues until the sugar in the cane is exhausted What remains of the cane is called bagasse and is used for fuel in the mill or for the manufacture of paper products and fiber board

The juice from the crushers is purified by adding milk of lime and the excess alkali is neutralized by adding sulphur dioxide The juice is then evaporated to a syrup and the syrup is heated until crystals of sucrose form. The mass is dropped into centrifugals and spun until the excess syrup is removed leaving raw sugar The syrup is then re-heated and again put through the same crystallization process When the syrup can no longer be profitably re-heated it is called plantation molasses and is used for stock foods, alcohol manufacture fertilizer or it is burned to obtain potash

The raw brown sugar is packed in 100 pound burlap bags and is shipped to the refinery The skin hazards in the cane sugar factories are similar to those in the beet sugar factories Since modern machinery and safety precautions are replacing old methods of production in the manufacture of raw sugar the skin hazards in this industry are becoming less frequent.

SUGAR REFINING

The moisture content of properly dried raw sugar is less than 1 per cent and the spores of bacteria and fungi do not readily grow in it If the moisture content is high it forms a suitable culture media for bacteria and workers who handle such low grade raw sugar often develop *dermatitis folliculitis and furunculosis* of the exposed parts of the skin.

The burlap bags used to hold the sugar are rough shred and irritate the skin of the hands and back of the carrier when lifted or carried Workers in refineries and others who load and unload cargoes of raw sugar may be affected

To prevent dermatitis from the loose fibers of jute bags it is the practice in one refinery to shake them in a shaker for ten minutes. Most of the loose fibers fall away and are sucked up by vacuum Jute bags can also be dipped in a 0.25 per cent solution of latex and allowed to dry in a hot room This will size the bags and keep them from shredding

In a modern refinery the bags of sugar are placed on a conveyor where they are automatically weighed and carried either to storage or directly to process. While the sacks are being weighed a sampler punctures the bags and obtains samples for analysis because the pay for raw sugar is based on its sucrose content. The sampler uses a long grooved bayonet which he thrusts into the bag A sample of sugar remains in the groove of the bayonet as it is withdrawn from the sack. The sampler's palm is heavily calloused from forcing the sampling instrument into the bag of sugar This operation may become difficult if the sugar is caked and under such conditions the skin of the palms may become cracked and swollen

The raw sugar to be processed is elevated to the melt house on the top floor of the refinery and mixed with hot syrup in an open trough forming a doughy mass called "magma This is discharged into open top mixing tanks The mixture is discharged into centrifugals and spun so that the layer of molasses is removed leaving the sugar lighter color The sugar is then dropped into tanks called pre-melters where it is heated and dissolved in the clear syrup The solution is then mixed with Kieselguhr (a fine powder of high porosity having a gray or reddish tint and consisting of the silicous skeletons of diatoms) and filtered in a press through a fine wire mesh covered with cloth The filtered liquor from the press is further purified by passing through large tanks of bone char Each filter tank of bone char is cleaned out after a certain number of charges have passed through it and the bone char removed and reactivated The men who do this work must enter the filter tanks to remove the char and in doing so they become covered with carbon and keratoses similar to those described on the hands of petroleum and coal tar workers are often seen on their hands

The liquors coming from the bone char filters are again spun in centrifugals to obtain the different grades of white sugar The white sugars consist of nearly 100 per cent sucrose. Powdered sugar has added to it about 3 per cent of corn starch. Brown sugar from refineries is about 87 per cent sucrose and the remainder is inorganic salts and reducing sugars.

In a modern refinery few cases of occupational dermatoses occur There is a minimum of contact with the sugar the refining being done enclosed and automatically and the sugar conveyed by belt conveyors to all parts of the plant.

Sugar dust rises everywhere in the factory but vacuum sweepers continually collect it and it is put back into process and the sugar recovered. Continuous steam jets in various parts of the factory keep the air moist to prevent sugar dust explosions.

The workers who open the 100-pound burlap bags of raw sugar and empty them into the bins preparatory to making the "magma suffer from dermatitis and fissures of the fingers caused by friction against the string which closes the bag and by the entrance of sugar crystals into whatever cuts or abrasions may be present. The acid perspiration splits the sucrose into invert sugars dextrose and

levulose and the levulose which is extremely hygroscopic withdraws moisture from the skin causing it to chap and crack. The men wear cotton covers over their shoes extending up over the trousers to prevent the entrance of sugar into the shoes. They should also wear cotton gloves to protect the hands.

Girls working at the machines which automatically fill boxes with powdered sugar may develop a dry scaling dermatitis of the fingers and dorsum of the hands, caused by the hygroscopic action of the powdered sugar. These girls should wear white cotton gloves and at the end of the day they should rub a vegetable or animal fat into the skin.

Workers who perspire excessively should not be placed on jobs in which the skin comes in contact with sugar because of the action of the acid perspiration on sucrose described above. New workers who handle burlap bags of sugar at first develop sore and swollen hands but after a week or two callouses form and the trouble subsides.

A similar condition has been observed among workers who pack 10-pound cotton "pockets" of sugar in large boxes. In this operation they are required to grasp the bag, lift it with one hand and place it in a large box. Although most of them develop callouses after a few weeks at this work, some of them develop swollen hands with open blisters and painful fissures on the palms even after six weeks of continuous work.

Men who fill and lift bags of sugar sometimes develop tenosynovitis of the wrists and forearms.

Women are employed to sew the burlap bags used for sugar and the lint which sheds from the burlap irritates the skin of the forearms. To prevent this, women employed at this operation should wear long sleeves.

The burlap bags in which the raw sugar is brought to the refinery are washed and laundered and then used again. Lint is shed by the burlap as it is dried and some workers who handle the bags suffer from dermatitis of the forearms similar to that affecting the women bag makers.

Moist crystals of sugar are placed in molds to form flat slabs of sugar. These are dried and then cut into small cubes or rectangular blocks. The girls who remove cubes of sugar from the trays and pack them into paper containers sometimes develop painful erosions of the fingers from cuts by sugar crystals and callouses on the hands from handling the metal trays. The girls who pack the rectangular crystal tablets of sugar also develop erosions of the fingers from the sharp crystals and should wear white cotton gloves or finger cots to prevent this condition.

Many of the workers in sugar refineries who handle cubes or crystals of sugar suffer abrasions of the finger tips which become extremely sensitive to the pricks of the sugar crystals. This is due mostly to the mechanical action of the sharp crystals of sugar and not to any chemical effect on the skin. Patch tests have been per-

formed on a number of girls working in a sugar refinery with crystals of sugar and with powdered sugar and in no case has there been a positive reaction

Sugar dust deposited on the teeth and gums of workers in sugar manufacture and refining is said to cause premature decay of the teeth, especially among those workers who neglect dental hygiene. This condition is not frequent among American workers in refineries who take better care of their teeth than do Europeans

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CHAPTER XXXVII

DERMATOSES CAUSED BY TOBACCO

Tobacco dust causes irritation of mucous membranes and gingivitis and stomatitis have been reported to occur with unusual frequency among tobacco workers. Damage to the nails of one or two fingers and painful hyperkeratoses have also been noted. Collis has reported 87 cases of dermatitis among workers who twist tobacco and states it is due to the olive oil applied by hand to the tobacco during this process. In modern factories this process is done by machinery.

Franchi Filippo reports dermatitis among tobacco workers and proved by patch tests to be due to hypersensitivity to a paste which contains a ferment applied to the tobacco leaves to aid the curing process.

Dermatitis among tobacco workers due to hypersensitivity to the tobacco leaf itself has rarely been reported.

Karrenberger, however, reports a severe case of dermatitis in a tobacco worker proved by patch tests to be due to hypersensitivity to tobacco leaves handled by the worker. He concludes that skin hypersensitivity to tobacco is rare among tobacco workers and has never been reported among smokers.

Tobacco (genus *Nicotiana*) belongs to the family of Solanaceæ and is related to the tomato, potato, egg-plant, red pepper and jimson weed plants. There are about fifty species of Nicotiana but commercial tobacco is made from varieties of *Nicotiana tabacum*.

Tobacco is now grown principally in South America, the Philippines, India, Sumatra, Java, Persia, Turkey, Egypt, Cuba, Puerto Rico, and in the United States, the principal tobacco-growing States being Tennessee, Kentucky, Missouri, Ohio, Maryland, Pennsylvania, Connecticut, Wisconsin, Florida, North and South Carolina, and Louisiana.

Tobacco was smoked in pipes and in the form of rolls of dried leaves by the Indians before Columbus discovered America. They also chewed and snuffed it. It was introduced into Europe by the Spanish friar Thevet in the year 1517. John Rolfe was said to have begun to grow tobacco in Virginia in the year 1612.

In the United States the principal types of commercial tobacco are: (1) Cigar leaf. (2) Dark fire-cured export, which is rich in nicotine and has a smoky creosote smell from absorption of the products of combustion during the curing process. It is chiefly used for the wrappers of plug tobacco and for snuff. (3) White Burley, which has the property of absorbing the liquid sweetening used in the manu-

This report is based on studies made in 14 cigar manufacturing plants employing more than 5,000 workers and on statements obtained from the officers of the International Cigar Makers Union of Tampa, Florida.

facture of chewing tobacco but which is also used in cigarette and pipe tobacco (4) Yellow tobacco or bright flue-cured tobacco used for cigarettes pipe and chewing plug (5) Dark air-cured manufacturing tobacco (6) Maryland and Eastern Ohio export. (7) Virginia sun-cured tobacco Types (5) (6) and (7) are all used for smoking purposes. (8) Perique tobacco grown in Louisiana and used to give aroma to fancy smoking mixtures. (9) Cuban tobacco which has a fine aroma and is used mostly in the manufacture of the higher priced cigars. Tobacco is grown from Cuban seed in the United States, but it is not deemed to have the fine aroma of that grown in Cuba.

Tobacco seeds are sown in hot beds garden frames and greenhouses and in the Spring the seedlings are transplanted to fields Fertilizers such as cotton-seed meal blood sulphates carbonates and phosphates are extensively used to enrich the soil of tobacco plantations and dermatitis may occur among the planters from the careless handling of these fertilizers. Many parasites attack the tobacco plant so that insecticides and fungicides such as lead and arsenic are used during the growing season to kill insects and molds. Dermatitis may occur among the spreaders of the insecticides, most of which are skin irritants. In tropical and sub-tropical countries as well as in our Southern States the laborers in tobacco fields are sometimes affected with ground itch and larva migrans

As the tobacco plant grows the tops of the plant are sometimes cut off in order to develop the lower leaves. In the early autumn the tobacco is harvested either by cutting the stalk near the ground when the tobacco is ripe or by plucking the individual leaves from the plant from time to time as they ripen. The stalks are split in two and placed on sticks and the leaves are strung individually on cords. Both are then hung in barns to cure. Air-curing under natural conditions is used for cigar tobacco and requires from three to twelve weeks Flue-curing barns are artificially heated by steam or otherwise no smoke being allowed to come in contact with the tobacco The heat of flue-curing varies from 90° to 180° F and the process lasts from three to five days. Fire-curing consists of building fires in the barn and subjecting the leaves at two or three day intervals to the action of heat and smoke. The cured leaves are then sorted and tied in bundles of 40 to 50 leaves called "hands"

After the curing process the tobacco for cigars is made to undergo a sweating process In this process the "hands" are stacked under canvas and fermentation takes place in the mass the temperature in it rising as high as 135° F Ammonia, nicotine carbon monoxide carbon dioxide and furfural are some of the constituents of the fumes given off during the sweating process The sweating is allowed to continue until the temperature of the tobacco returns to 90° F or less and then it is stopped and the hands tied in bundles of four called carrots. Eighty "carrots" are placed in bales or cases if to be used for cigar making. Tobacco for other than cigar making purposes is packed in hogsheads

CHAPTER XXXVII

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[1] This report is based on studies made in 14 cigar manufacturing plants employing more than 5,000 workers and on statements obtained from the officers of the International Cigar Makers Union of Tampa, Florida.

an adhesive. This is called "rolling." The adhesive usually consists of a mixture of water and tragacanth, although licorice may be added to it. The fingers are dipped into the adhesive and some of it is placed on the edges of the wrapper so that the cigar can be sealed. The end of the cigar which is to be placed in the mouth is then shaped and pasted down and the other end cut off to the required length. Excess tobacco and small pieces cut off the wrapper are used for short filler cigars.

The cigars are then sorted according to color of wrapper and placed in cedar boxes which are stored in air-conditioned rooms until ready for shipment. Just before shipment they are taken out of the boxes, banded, placed in cellophane holders either by hand or by machine, and then re-boxed in cedar boxes and sealed. The boxes are then trimmed and labels pasted on them. The girls who paste labels on the boxes at times contract dermatitis from the paste composition. In some factories where this has occurred the use of ready-made paste has been discontinued and the paste now used consists of a simple solution of tragacanth in water mixed in the factory.

Short filler cigars are made by cutting filler leaves and scraps into smaller pieces. The cut tobacco is cleaned of dust by shaking and sieving in machines before it is placed in cigars. In this cleaning operation, considerable dust is developed which irritates the mucous membranes of those unaccustomed to it, but it seems to cause no inconvenience to the workers. In bonded factories the stems and waste of imported tobacco are burned under Government supervision to recover duty paid on the tobacco.

Before boxes of cigars are shipped, some manufacturers fumigate them in disinfecting chambers, using hydrocyanic acid gas or a preparation known as "Caurdite" to destroy whatever parasites may remain in the tobacco.

Machine-made cigars are of short filler which is gathered automatically from a shallow container by suitable sized clamps or jaws and conveyed into a mold to be automatically "bunched." The bunch is rolled automatically into a "binder" spread by the machine operator. The bunch is then placed in a machine which wraps and seals the cigars.

Nicotine ($C_{10}H_{14}N_2$) is the principal toxic substance of tobacco. It is present in from 1 to 10 per cent, in the different varieties of tobacco. In addition to the nicotine, tobacco contains nicotianine, nicotinine, nicoteine, nicotelline, and traces of malic, citric, oxalic and nitric acids. Plucked tobacco leaves may also contain traces of arsenic and lead.

Nicotine is liberated during the fermentation, "sweating," or "curing" processes, but apart from irritation of the mucous membranes and headache among apprentices, symptoms of nicotine poisoning are rare among tobacco workers. Nicotine poisoning, however, is much more frequent among workers who handle nicotine used as an insecticide or plant disinfectant.

Sulzberger states that nicotine is unimportant in the sensitization

of the skin to tobacco It is not the nicotine which elicits the skin reaction in those hypersensitive to tobacco The sensitizing substance is one which is coctostable thermostabile and not destroyed by ultra violet or roentgen-rays in the dosages employed by him

In the present study there were no active cases of dermatitis seen which were due to tobacco A number of workers were found who stated that they at times developed a dermatitis beginning in the web of the fingers and spreading up the forearms which they said was caused by handling certain batches of tobacco leaves Some said it was caused only when handling certain types of American grown tobacco while others were certain that it was caused by foreign grown tobacco Most of these workers handled tobacco before it was fully cured and before it was ready to be made into cigars No such histories were encountered among workers who actually rolled bunched or sorted the finished cigars Patch tests with various tobacco leaves performed on a number of workers who gave a history of dermatitis failed to produce any positive reactions.

When it is considered that various tobaccos contain traces of irritating chemicals used as insecticides and fertilizers that in addition some of the leaves are wetted with flavoring agents such as wine and vanilla and that some very cheap and badly burning tobaccos are even treated with solutions of sodium nitrate to make them smoke better the occurrence of dermatitis among some tobacco handlers at irregular intervals can be easily understood The negative results of patch tests in these cases may be due to the fact that the leaf with which the tests are performed does not contain the irritants *present in the batch of leaves which caused the dermatitis*

Although Sulzberger has shown that a considerable percentage of smokers and non-smokers have cutaneous sensitivity to tobacco extract dermatitis among tobacco users due to tobacco sensitivity has not been reported

Tobacco smoke is said to contain tar nicotine collidine picoline pyridine ammonia salts (especially ammonium cyanide) cyanogen arsenic lead carbon monoxide and carbon dioxide and although these substances come into intimate contact with the skin during the act of smoking dermatitis from tobacco smoke has not been reported

The irritating effect of tobacco smoke on mucous membranes is well recognized and McNally concludes that the constituents of the tar of cigarette smoke can account for the cigarette cough bronchitis and leukoplakia of heavy smokers as well as for the recorded increase in cancer of the lungs The experiments of Lickint and of Bogen and Loomis fail to substantiate the carcinogenic action attributed to tobacco smoke

It is said that the last 1 or 2 inches of a cigarette or cigar when smoked holds the greatest concentration of the constituents of the smoke and therefore should not be smoked The removal of a considerable percentage *of nicotine tar and pyridine bases from tobacco*

smoke can be accomplished by the treatment of the tobacco with certain patented processes such as exposure to ethylene oxide extraction with nitric and phosphoric acids, or by using de-nicotinizing cigarette holders which absorb a great deal of the smoke

Because the irritating action on mucous membranes is mostly attributed to cigarette smoke it has been thought that the combustion products of glycerine used as a hygroscopic agent in cigarette tobacco are the cause of this irritation. Mulinos and Osborn and Flinn have found that when diethylene glycol is used as a hygroscopic agent instead of glycerine the irritating effect of the smoke on the mucous membranes is markedly diminished or disappears altogether

Dermatitis among tobacco workers occasionally occurs. It is mostly due to (1) the mechanical trauma involved in hand-stripping (2) pastes used on cigars and boxes (3) chemicals used as processing or flavoring agents and (4) in rare cases hypersensitivity to tobacco In the latter cases the actual irritant is more likely to be traces of insecticides remaining on the tobacco or chemicals given off by the various curing processes than to any natural constituent of the tobacco leaf While irritation of the mucous membranes, eyes and the respiratory tract are caused by tobacco smoke cases of dermatitis have not been reported from this source

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CHAPTER XXXVIII

IRRITANT PLANTS AND WOODS

This chapter comprises a list of the known plants, flowers, tree woods, weeds, fruits and vegetables which are capable of irritating or sensitizing the glabrous skin.

The principal plants of North and South America, territories of the United States, Europe and the Tropics are herein described, as well as the irritant members of the fruit, vegetable and weed families.

Certain plants may only be toxic or irritant when grown in certain localities and only in certain seasons or stages of their growth. The spines, roots, stems, sap, leaves or flowers may be irritant although the irritant is usually contained in the whole plant, but in different concentrations. Some of the irritant principles are also systemic poison, although some of the systemic poisons may not be skin irritants. Some of the plants contain photosensitizing principles. Most of the plants listed are sensitizers. Some of the juices are acrid primary irritants as well as sensitizers.

There is confusion in the identification of many woods reported to have caused dermatitis. This because the names given to woods in new localities are in some cases those already in demand from old localities, although the wood may be of an entirely different family. Under such popular names as coco-bolo, rosewood, mahogany, box wood, satinwood, Brazilian walnut, etc., are sold a variety of woods in many cases of totally related families and from different parts of the world. For instance, boxwood may be the white dogwood of the family Cornus from Florida, or the yellow wood of the family Fabaceae, or the Buxus sempervirens. Considerable time was spent by the authors in consultation with botanists and in searching for names in encyclopedias in order to identify the woods.

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LIST OF IRRITANT PLANTS

Alismaceæ (*Alisma plantago-aquatica*) —Water plantain. (Weber.)

Altingiaceæ (*Liquidambar styraciflua*) —Sweet gum (Weber.)

Amaryllidaceæ (*Narcissus bulbs*) may produce a dermatitis of the phalanges from which the skin may peel on slight friction.

Sub-varieties of the narcissus, notably the daffodil and jonquil frequently cause a dermatitis known as "lily rash" among flower packers and gatherers in England and the Scilly Isles. Humidity cuts and abrasions on the hands of the workers appear to increase the severity of the eruptions. Even dogs running through the fields are said to develop eczema from this source.

In America very little has appeared in the literature regarding this disease although it is well known among flower growers. A man operating a large greenhouse in St. Louis, together with 20 per cent of his employees acquired severe dermatitis from working among jonquils. Patch tests with the sap of this plant have produced erythema and vesiculation with the petals, erythema and with the pollen, no reaction.

Other members of this family reported to have caused dermatitis are

Narcissus jonquilla.—Jonquil

Narcissus pseudo-narcissus —Daffodil.

Agave Americana —Century plant.

Agave lechuguilla —Century plant.

Ambrosiaceæ. (*See Compositæ.*)

This family includes the ragweeds and marsh elder (Weber.)

Ambrosia artemisiæfolia.—Ragweed

Ambrosia elatior —Ragweed.

Iva xanthifolia.—Marsh elder (Stevens.)

Iva angustifolia (Shelmire.)

Ragweed (*Ambrosia Compositæ*) —This common plant is capable of producing a dermatitis during the period of pollination in the summer and autumn. The theory formerly held that this affection is due to the antigenic atopic excitant of the pollen has been disproved by recent experimentation, and it is now believed that it is a contact dermatitis produced by an oil of the plant.

The eruption occurs first on the face, neck and arms, but through continued exposure may spread over the entire body and cause total disability It consists of diffuse erythema and superficial desquamation with very little vesiculation. Ragweed dermatitis is most frequent among farmers but may also occur among persons engaged in other work in the open fields.

Brunsting and Williams in 1930 reported a series of patch tests with oil of ragweed on 48 patients and found that the short variety of ragweed produced the greatest number of positive reactions. *Burweed Marsh Elder (Iva)* a related plant and Western ragweed proved only slightly less irritating while giant ragweed was almost innocuous. There appeared to be very little relation between contact sensitivity and mucosal allergy to various proteins and inhalants

in the patients tested. Attempts at desensitization by intramuscular injections of the plant oils over a period of two to three years failed to prevent seasonal recurrence in 10 of 24 patients; 3 cases were doubtful, and only 2 patients were entirely free from symptoms during the following season.

Sulzberger and Wise in 1930 reported a case of ragweed dermatitis in an insurance agent living in the country where he was constantly exposed to contact with the weed. They were able to treat the disease successfully during the season by intradermal injections of "ragweed pollen allergen" into the most superficial part of the skin. Injections were made in three different areas and were repeated three times a week for nearly four weeks. After the first two weeks no new lesions appeared and the existing symptoms gradually subsided. These observers believe that intradermal injections offer better promise of desensitization than those given by the subcutaneous route.

The failure to produce immunity to ragweed in the great majority of cases reflects the common experience with chrysanthemum, pyrethrum, and ivy.

Anacardiaceæ.—This family of plants and woods is probably the cause of more dermatitis than all the other families combined. The poison ivy of the Atlantic Coast, the poison oak of the Pacific Coast, poison sumac, the Japanese lacquer tree, the Indian marking nut, the cashew nut tree, and the oil of the shell of the cashew nut have a worldwide reputation as dermatitis producers.

Dermatitis has been reported not only from the fresh plants and trees and fruits, but also from commercial products made from them, such as lumber, lacquers, varnishes, and resins, as well as from objects coated with lacquers, varnishes and resins derived from plants of this family.

The leaves of many plants of this family are covered with short sharp spines, easily seen with a low-power lens. When these spines are broken off the irritant sap oozes out of the leaf. The roots of the plant are filled with a sticky irritant sap so that digging in the soil where they may be is often the cause of dermatitis.

The active irritants in this family of plants are polyhydric phenols which differ slightly in their chemical formulæ. They are all primary irritants in pure form as well as sensitizers. The skin irritant properties are destroyed by complete oxidation. But incomplete oxidation may form irritant compounds.

Oxidizing agents such as potassium permanganate, sodium perborate, hydrogen peroxide, ferric chloride, will destroy the irritant properties of these polyhydric phenols *in vitro*, and if properly applied will do so on the skin.

The symptoms of dermatitis from the anacardiaceæ first manifest themselves from a few hours to several days after contact, with itching on the parts contacted, usually the fingers, hands, forearms, and legs. Papules soon appear, and they have a tendency to appear in linear formation. They soon become vesicles which may vary in

size from pin point to large bullæ. The vesicles are superficial being situated in the epithelial layer of the skin. In severe cases the face, eyes, and parts of the body may be affected. The toxin may be carried from one part of the skin to another and thus spread the eruption but contrary to popular opinion the fluid in the vesicles does not contain the toxin but is only ordinary serum of inflammation. Clothes, tools and the fur of animals may carry the toxin. Constitutional symptoms are rarely present. The eruption comes out in crops, the part of the skin having had most contact with the irritant being first affected and part having had least contact being last affected. However all of the eruption is usually out after forty-eight hours.

If untreated the vesicles break, or are scratched open and if secondary infection does not take place they are all healed inside of seven days and leave no scars.

Treatment.—As soon as the first signs of dermatitis appear in the form of itching and papules, the parts should be washed with soap and water followed by alcohol to remove whatever of the toxin remains on the skin. This should be followed in mild cases affecting the hands, arms, or legs, where there are just scattered papules and vesicles with but little edema, by vigorous rubbing of the papules and vesicles with alcohol saturated gauze. The rubbing should be sufficiently hard to abrade papules and break small thin walled vesicles. Large vesicles should be opened with a sterile knife. This procedure is not as painful as one would suppose. In many cases the patient is immediately relieved of the itching. The alcohol rubbing should be followed by immersing the part in a 10 per cent solution of tannic acid for thirty minutes or by applying a wet dressing of the tannic acid solution for thirty minutes. The treatment should be repeated after six hours in order to break new crops of papules and vesicles. Usually three or four treatments are sufficient to scab over all the vesicle sites and the symptoms are entirely relieved. The scabs disappear at the end of five to seven days. In severe cases affecting the face the tannic acid-alcohol treatment should not be used. Instead wet dressings of boric acid solution or Burow's solution 1 to 20 should be applied. The treatment described above is applicable to dermatitis from all plants.

Prevention.—Field workers and others who are going to work in places where poison ivy, poison oak, or other members of the anacardiaceæ are likely to be encountered should see that they wear long trousers, long sleeves and gloves. If gloves cannot be worn for any reason a protective ointment containing an oxidizing agent should be applied on the hands and even the face. The following is a preparation which will dry on the skin leaving a film which gives physical protection and sodium perborate which gives chemical protection.

Shellac	10	Carbitol	5
Alcohol	55	Talc	20
Sodium perborate	10		

After returning from the field the clothes should be taken off and decontaminated by soaking in a 1 per cent solution of calcium hypochlorite for fifteen minutes and then laundered. The body should be cleansed with soap and water and fresh clothes put on. Tools should also be decontaminated. These preventive measures apply to all dermatitis from plants.

Fig. 87 —Toxicodendron radicans. Poison ivy. Eastern U. S.

Hyposensitization to the anacardiaceae can be obtained in many patients by giving subcutaneous injections of the plant extract in ascending doses. Hyposensitization has also been obtained by giving the poison ivy extract in ascending doses by mouth mixed with corn oil and in gelatin capsules. *Hydro urushiol*, the active ingredient of *rhus toxicodendron* and *rhus vernicifera* can be given by subcutaneous injection instead of the poison ivy extract. The initial dose should be very small, of the order of a few micrograms.

Poison Ivy (*Rhus toxicodendron*) is very common in this country and is considered one of the most toxic of the sumacs. (Figs. 87 and 88.) Experiments by Spain and Cooke have shown 65 per cent of their patients sensitive to poison ivy by patch tests. (Fig. 89.)

Dermatitis from contact with this plant is frequent among gar

deners, field laborers foresters, C. C C camp workers and others whose employment brings them into the open. The vine clambers over rocks, trees, and banks, thriving best in low places. The leaves and flowers contain an acrid juice whose active principle is toxicodendrol and the hairs of the plant produce a mechanical irritation of the skin that facilitates the action of the irritant. Inflammation

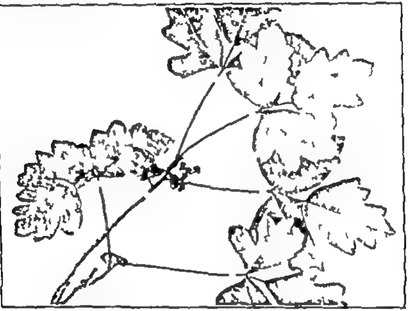


FIG. 88.—*Toxicodendron quercifolium.* Oak leaf poison ivy Eastern U S

FIG. 89 —Rhus (ivy) dermatitis (occupational) in gardener

begins in a few hours to several days after contact, and is followed by erythema, swelling vesicles, and serous bullæ Marked swelling is likely to occur around the eyes and genitals. The hands, arms, face neck, and genitals are the usual sites of eruption but any part of the skin may be involved except where the hair is thick.

Repeated attacks of ivy poisoning do not confer immunity although in the recurrent cases the vesicles may exist in well defined

patches without much swelling or erythema. Abscesses are an occasional complication

Sollmann states that the poison may be conveyed to the skin by soot from the burning leaves of this plant.

Experiments in sensitization by Field and Sulzberger in a person previously unaffected by poison ivy caused an eczematous reaction in nine to ten days. After sensitivity had been established, the incubation period was reduced to twenty-four from seventy two hours.

FIG. 90.—*Rhus diversiloba poison oak. (Pacific Coast.)*

Maisel stated that desensitization was obtained by daily immersion in a bath to which tincture of poison ivy had been added in gradually increasing concentrations.

Poison Oak (*Rhus diversiloba*) is said to be even more toxic than poison ivy (Fig 90) Its active principle is *lobinol*, an amber red non-volatile oil which produces an extremely severe form of dermatitis.

Poison Sumac, Poison Elder or Poison Dogwood (*Rhus venenata* or *vernix*) (Fig 91) is a shrub which grows on swampy ground in the United States, Canada and Japan. It is said to be the most irritating of all the sumacs, producing an intensely itchy dermatitis in persons who work in its vicinity

Fig. 91 —Toxicodendron vernix. Poison sumac.

Smoke Tree, or venetian sumac (*Rhus cotinus*) is a common shrub in this country and yields a yellow dye called fustin a poisonous alkaloid

Jamaica Sumac (*Rhus metopium*) —This tree grows in tropical America. It is also known as the *coral sumac* or *mountain manchineel* Contact with the fresh juice of the tree brings on a particularly severe dermatitis in some persons. *Cardol* is said to be the active irritant.

Lacquer (*Rhus vernicifera* the Lacquer Tree of China and Japan) —This tree contains a milky white sap which hardens on exposure to the air and is the source of the familiar dark-colored varnish known as lacquer This substance is extremely toxic and causes cutaneous eruptions among persons gathering it those handling it in manufacture, and occasionally among persons who use freshly lacquered articles.

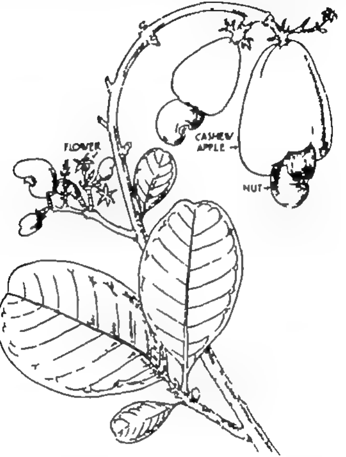


FIG. 92 —A fruiting branch of the cashew showing flower fruit and leaves (After Greshoff III Koloniaal Museum Extra Bul Afl 1 6 1891)

Harmful effects may be produced by the fresh sap or by lacquer that has long been hard and dry if heated or dissolved in alcohol Toyama has shown that even after a thousand years lacquer may be irritating Its ready solubility in fat hastens its action. The active irritant *urushiol* (or possibly vernicerol) readily penetrates the sweat ducts, the papillary layer and the hair follicles and excites an inflammatory process. Chinese lacquerers, who are most exposed are said to wear gloves at their work to avoid contact with the substance.

A gardener in the botanical gardens of Vienna is reported to have developed wheals on the exposed parts of his skin and on the genitals after cutting down a lacquer tree, and similar eruptions have occurred among persons transplanting young trees. Contact with lacquered canes has been known to produce large inflammatory wheals. Expensive, highly finished boxes for Mah Jong sets may cause dermatitis. A few cases have been reported in America due to these and other imported lacquered articles.

Cashew Nut (*Anacardium occidentale*).—The cashew nut is a native of Brazil and the West Indies and has been introduced into Asia, Africa and the Far East. (Fig. 92)

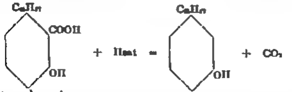
The tree is a spreading evergreen which attains a height of between 30 to 40 feet.

The nut, 1 to 1½ inches in length, is kidney shaped and is attached to a pear shaped enlargement of the stalk about 2 to 4 inches long. This portion is edible when ripe and is called the "cashew apple." The kernel is contained in a husk consisting of a soft oily gray outer portion and a thin interior membrane. Between these layers is a resinous material which serves as a protection from insects.

When the "apple" is ripe the nuts are plucked and dried in the sun. Later, when the nuts are heated, they swell and eject a resinous liquid which is a powerful skin irritant. This preliminary heating is necessary so that the nut can be broken without damaging the kernel. After the kernels are removed, they are dried, roasted and salted for eating.

The cashew nut shell liquid is obtained either by roasting the shells as is the common practice in India, or by solvent extraction which is said to produce a much greater yield of oil. This oil has been shown to be a mixture of 90 per cent monohydric phenol (anacardic acid) and 10 per cent polyhydric phenol (cardol). The anacardic acid which occurs in the plant becomes changed to anacardol in the manufacturing process by losing carbon dioxide. Anacardol is a monohydric phenol.

CONVERSION OF ANACARDIC ACID TO ANACARDOL



Anacardic acid — Anacardol

The cardol fraction is believed to contain the major irritant properties attributed to cashew nut shell liquid and is chemically related to urushiol, the irritant principle of poison ivy.

Cashew bark exudes a gum used as a substitute for gum arabic. It is employed in the manufacture of mucilage and varnish. The juice collected from incisions in the tree trunk turns black upon

exposure to air and is used as an indelible marking ink just as the juice of the *semecarpus anacardium*

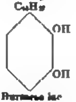
Dermatitis may result from contact with the juice or with materials impregnated with it as a marking ink. Skin irritation may also be caused by the resinous exudate used in mucilage. It is possible that the occasional case of dermatitis attributed to gum arabic is actually caused by this cashew resin

Occupational dermatitis has occurred in several workers at this plant where cashew nut shell liquid and its products are handled The greatest incidence has taken place in the warm months among those workers employed in handling oil and resins which are incompletely cured It was estimated at the plant that of every 10 new employees who handle the raw cashew nut shell liquid 4 will develop dermatitis and of these 4 1 will experience a severe attack, the other 3 being mild cases.

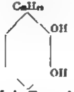
Indian Marking Nut (*Semecarpus anacardium*) —This deciduous tree grows in the tropical Himalayas and the hotter parts of India

TABLE 13.—THE KNOWN IRRITANT PRINCIPLES OF ANACARDIACEAE AND RELATED PLANTS (After Hack)

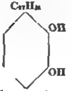
Plant (Bot.)	*Common Name*	*Chief Component*
Rhus vernicifera D C	Japanese lac tree	Urushiol
Rhus toxicodendron Linn	Poison ivy	Toxicodendrol
Semecarpus anacardium	Marking nut	Bhilawanol



Semecarpus heterophylla	Burmese lac	Renghol



Rhus succedanea Linn	Indo-Chinese lacquer	Laccol
Rhus ambigua Lav	Tsuta-urushi lacquer	Laccol
Semecarpus vernicifera	Formosa lac tree	Laccol



Gluta renghas Linn	Javanese lac tree	Glutarenghol

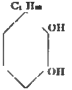
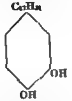
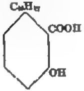
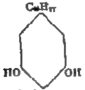
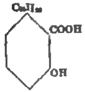
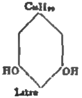
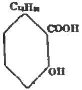


TABLE 12.—(Continued)

Plant (Bot.)	*Common Name*	*Chief Component*
Melanorrhoea usitata Wall. *Melanorrhoea laccifera*	Burma lac tree Thitsi tree 	Moreakol Thitsiol
Anacardium occidentale	Cashew nut tree 	Anacardic acid
		Cardol
Ginkgo biloba Linn.	Ginkgo tree 	Ginkgolic acid Bilobol
Pentaspadon motleyi Hook.		Pelandjauic acid
Lithrea caustica	Litre 	Litrol

It is 20 to 40 feet high and 4 to 6 feet thick. It bears a plum-like fruit the flesh of which is orange-red, sweet and edible. The pericarp contains a dark brown to black resinous corrosive juice which is

Does not belong to the Anacardiaceae

used for making black identification marks on linen. It has been credited with medicinal properties and has been prescribed for various ailments. The juice is a marked vesicant. Three irritant ingredients have been isolated from the black juice of the pericarp (1) monohydroxy phenol (semecarpol) (2) a dihydroxy phenol (bhilawanol) and (3) a tarry corrosive residue.

Anacardiaceae

Rhus cotinus
Rhus coriaria.
Rhus diversiloba.—Poison oak.
Rhus metopeus
Rhus vernicifera.
Rhus vernix—Poison sumac, elder or ash.
Rhus caustica—Litre.
Semecarpus anacardium.—Marking nut tree.
Anacardium occidentale—Cashew nut tree.
Mangifera indica.—Mango tree.
Pistacia terebinthus
Schinopsis lorenzii—Quebracho.
Loxopterygium huasango—Hualtaco tree.

Anonaceae

Asimina triloba—Pawpaw (Muenscher.)

Apiaceae

Daucus carota—Carrot (wild and cultivated) (Peck.)
Apium graveolens—Celery
Archangelica officinalis—Angelica.
Conium maculatum.—Poison hemlock.

Apocynaceae

Nerium oleander—Oleander (Muenscher.)
The milky juice exuding from the leaf is poisonous.
Plumeria rubra.—Dogbane.

Araceae

Arisaema triphyllum.—Jack-in-the-pulpit. (Muenscher.)
Philodendron consanguineum (Weber.)
Symplocarpus fœtida.—Skunk cabbage. (Weber.)

A case was recorded in which the juice from the root of an Arum Lily (*Araceæ* Arum Family) handled by an apothecary in the course of his work caused severe inflammation of the hands, the toxin was carried to the genitals and the ensuing dermatitis culminated in gangrene.

Araliaceae

Ground Ivy (*Hedera terrestris* and *Hedera helix* or English Ivy of the *Araliaceæ* Ginseng Family) may produce dermatitis in some individuals. Touching the wet leaves repeatedly is reported to have caused a vesicular eruption resembling zoster in one patient. In other cases, an erythematous dermatitis of the face, hands, and arms is reported to have developed forty-eight hours after contact with the leaves.

Echinopanax horridum—Devil's club (Muenscher.)

Aralia spinosum.—Hercules club. (Muenscher.)
Arecaceæ
Sabal.—Cabbage palmetto.
Aristolochiaceæ
Asarum canadense.—Wild ginger. (Muenscher.)
Asteraceæ (*See Compositæ*)
Achillea millefolium.—Yarrow. (White.)
Helianthus annus.—Sunflower. (Weber.)
Berberidaceæ.—Barberry. (Muenscher.)
May Apple, or Mandrake (*Podophyllum peltatum*. *Berberidaceæ*).—The rhizomes and roots of this plant contain a resin which is used medicinally. Contact with the resin may cause an irritation of the skin, while dust from the substance attacks the mucous membranes of the conjuctiva and nose.
Caulophyllum thalictroides.—Blue cohol. (Weber.)
Bignoniaceæ
Jacaranda acutifolia.—Tree.
Jacaranda ovalifolia.—Tree.
Tabebuia pentaphylla.—Tree. (Occupation and health.)
Catalpa bignonioides.—Tree. (Weber and Muenscher.)
Catalpa speciosa.—Tree. (Weber and Muenscher.)
Campsis radicans.—Trumpet creeper. (Muenscher.)
Boraginaceæ
Borago officinalis. (Muenscher.)
Cynoglossum officinale.—Hound's tongue. (Muenscher.)
Echium vulgare.—Blue thistle. (Muenscher.)
Brassicaceæ
Lepidium sativum.—Garden cress. (Weber.)
Buxaceæ
The **Box Tree** (*Buxus sempervirens*), commonly used for hedges and borders, contains a milky acrid juice. Gardeners have suffered an erysipelatous dermatitis from contact with the leaves of this shrub.
Cactaceæ:
Opuntia.—Prickly pear. Indian fig.
Cannabinaceæ
Cannabis indicum.—Hemp. marijuana.
Carduaceæ
This family is often included in the *Compositæ*.
Arnica montana.—Mountain tobacco.
Doronicum.—Thistle family.
Encelia californica.
Erigeron canadensis.
Gaillardia pulchella. (Shelmire.)
Helenium autumnale.
Helenium tenuifolium. (Shelmire.)
Parthenium hysterophorus.—Fever few. (Shelmire.)
Parthenium argentatum.
Senecio cineraria.—Dusty miller.

Chenopodiaceæ

Spinach (*Chenopodiaceæ* Goosefoot Family).—In the canning industry workers employed in packing spinach are subject to a dermatitis resembling that produced by poison ivy the exact cause of which has not been determined Schulze and Ewing suspect the possibility of a fungous infection

Bassia latifolia.—Bassia wood teakwood Tree.

Bassia longifolia.—Tree.

Chlooriaceæ

Lactuca scariola.—Lettuce

The butt exudes a milky irritant sap

Compositæ

This is a large family (some of its members are often placed in other families) and contains many irritant plants.

Anacyclus pyrethrum

Anthemis arvensis.—Corn camomile

Anthemis cotula.—Dog fennel

Arctium lappa.—Great burdock.

Artemisia absinthium.—Wormwood

Calendula tagetes.—Legion of Honour ? (White.)

Cassinia. (White.)

Chrysanthemum cinerariæfolium.—Japanese daisy

Chrysanthemum coccineum.

Chrysanthemum indicum.

Chrysanthemum leucanthemum.—Daisy (Weber.)

Chrysanthemum parthenium.—Fever few

Cynara scolymus.—Artichoke.

Dahlia.

Oxytenia acerosa.—Copperweed

Tanacetum vulgare.—Tansy

Tetradymia canescens.—Gray horse bush

Tetradymia glabrata (Muenscher.)

Xanthium spectosum (Shelmire.)

Humea elegans (White.)

Golden Rod (*Solidago virga aurea*) a common autumn-blooming plant in Europe and North America, has produced a maculo-papular dermatitis accompanied by itching and burning among field workers following three to twelve hours work at haymaking The irritant is said to be carried by the pollen

Chrysanthemum leucanthemum (Ox-eye Daisy) and **C. indicum**, of the *Compositæ* have been responsible for dermatitis among florists and gardeners. The leaves and stalks of the former and the volatile oil of the latter in certain instances have been found to be most noxious.

Chrysanthemum coccineum (the *Pyrethrum roseum* of gardens) together with **C. cinerariæfolium**, are the source of Persian insect powder Gardeners and workmen who crush and pack the flowers to make the powder are frequently affected by eruptions. Four forms have been recorded from this source vesicular lesions, the

most common an erythematous form a papular eruption and an anaphylactic reaction. (See Insecticides.)

The common **Tansy** (*Tanacetum vulgare*) of the same family has been known to produce a pustular eruption.

Roman Leopard's Bane (*Doronicum pardalianches Compositæ*) is a European herb whose root contains acrid and poisonous juices. Diffuse redness of the face and hands has resulted from gathering the roots and flowers of this plant. The cutaneous irritation may also involve the bare feet of field laborers coming in contact with them.

Dog fennel (*Anthemis cotula*) contains valeric acid which will blister the skin.

Seaside Ragwort (*Cineraria maritima*) has an ash white fuzzy coating which can cause pruritus.

Camomile (*Anthemis nobilis*) has been reported to have caused dermatitis of the hands and feet of workers in flax fields where it grows wild Bandages wet with camomile applied to the eyelids have caused dermatitis.

Dermatitis has been reported from the common **Sunflower** (*Helianthus annus Compositæ*)

The leaves of the **Marigold** (*Calendula tagetes Compositæ*) may cause eruptions of the skin.

Lettuce (*Lactuca* of the Composite Family) is capable of producing dermatitis, as exemplified by the case of a woman salad maker reported by Rinkel The patient handled large amounts of lettuce in the course of her work, and for five years suffered from eruptions of the skin. The lesions were erythematous papular and vesicular and involved the hands and forearms and the skin around the nose and mouth. Urticarial eruptions also appeared from time to time accompanied by intense itching

Yarrow (*Achillea millefolium Compositæ*) —This plant abounds in open fields and farm laborers coming in contact with it have suffered severe cutaneous lesions. The symptoms usually consist of pruritus and pustules, which may ulcerate.

Mountain Tobacco Leopard's Bane (*Arnica montana Compositæ*) —This plant, from which medicinal arnica is derived contains the acrid alkaloid *arnicin* which produces in some persons an erysipelatous dermatitis.

Wormwood (*Artemisia absinthium Compositæ*) —This is a weed common to old gardens and to roadsides, whose flowers may cause a scarlatiniform rash in sensitized persons working in its vicinity

Coniferæ

Pistacia terebinthus —Turpentine tree.

A number of pine trees yield turpentine and rosin. Both may cause dermatitis.

Abies alba —Silver fir tree

Abies excelsa —Tree

Picea abies —Norway spruce tree

Picea canadensis —White spruce tree

Convallariaceæ
Convallaria majalis.—Lily of the valley.' (Muenscher.)
Asparagus officinalis.—Asparagus. (Muenscher.)

Asparagus is a common source of dermatitis in the canning industry among workers cutting and cleaning the vegetable. The rash consists of erythema, swelling and miliary vesicles and is said to be allergic.

Convolvulaceæ
Rhodorhiza scoparia.—Tree.
Crassulaceæ
Sedum acre.—Stone crop. (Muenscher.)
Cruciferæ
Brassica alba.—White mustard.
Sinapis nigra.—Black mustard.
Radicula armoracea.—Horse radish.
Sisymbrium officinale.—Hedge mustard. (Weber.)
Cucurbitaceæ
Sicyos angulatus.—Bur cucumber. (Weber.)
Cypridiæ
Cypripedium spp.—Lady slippers. (White.)
Droseraceæ
Drosera rotundifolia.—Sundew. (Weber.)
Equisetaceæ
Equisetum limosum.—Horsetail.
Ericaceæ (Heath Family.)
Oxydendrum arboreum.—Sorrel tree. (Weber.)
Euphorbiaceæ (Spurge Family.)

This is a large family and contains many irritant plants. The sap contains skin irritants, many of which are unidentified. Some of the leaves have prickles which may act as irritants.

Euphorbia variegata.—Japanese edelweiss.
Croton tiglium.—Croton plant.
Ricinus communis.—Castor plant.
Acidoton microphyllus.
Acidoton urens.
Euphorbia antisyphilitica.
Euphorbia corrollata.
Euphorbia cyparissias.
Euphorbia ipecacuanha.
Euphorbia lactea.
Euphorbia lathyris.
Euphorbia marginata.
Excœcaria agallocha.—Blinding tree, river poison.
Hippomane mancinella.—Manzanillo tree. (Manchineel.)
Hura crepitans.—Tree. (Weber.)
Jatropha curcas.—Tree.
Jatropha stimulosa.—Spurge nettle.
Jatropha urens.—Stinging physic nut.
Stillingia sylvatica. (Weber.)

Euphorbia Variegata (Japanese edelweiss).—Musger reported 2 cases of dermatitis due to this plant and states that the poison is contained in the milky juice of the plant.

Croton Oil Plant (*Croton tiglium Euphorbiaceæ*).—Contact with croton oil which comes from the seeds of this plant, may induce an impetiginous dermatitis in sensitive persons. The plant is said to vary in toxicity in different localities.

Castor Oil Plant (*Ricinus communis Euphorbiaceæ*) is a plant related to the *Croton tiglium*. The seeds yield castor oil which may occasionally cause cutaneous irritation.

Hura Crepitans.—The sap of this tree contains a toxin called hurin which causes an erysipeloid eruption.

Fabaceæ

Mucuna pruriens.—Cow-itch.

Cladastris lutea.—Yellow wood tree.

Fagaceæ (Beech Family)

Quercus robur.—English oak tree. (White.)

Castanea sativa.—European chestnut tree.

Castanea mollissima.—Chinese chestnut tree.

Andira araroba.—Vouacapoua tree.

Fleurya

Fleurya æstuans.—Resembles nettles. (Weber.)

Fumariaceæ

Dicentra spectabilis.—Bleeding heart. (White.)

Geraniaceæ

Geranium maculatum.—Wild or spotted cranesbill.

Geranium leaves sometimes cause dermatitis among florists.

Ginkgoaceæ

Ginkgo biloba.—Maiden hair tree. (Muenscher.)

The fruit is like a large cherry the pulp is irritant but the seeds are edible.

Gramineæ

Rice (*Oryza sativa*).—Dermatitis occurs from husking rice, either from mechanical irritation of the dust or allergy to rice proteins.

Timothy Grass (*Phleum pratense*).—Handlers of this common grass may develop a maculo-papular dermatitis, especially in August and September.

Millet, Broom Straw Sorghum (*Sorghum vulgare*) causes dermatitis among those who handle it. The exact cause has not been determined. Sorghums produce a glucoside dhurrin which can be hydrolized to yield prussic acid.

To certain **Pond Weeds** (*Naia major* and *minor*) has been attributed a virulent form of dermatitis that attacks whole shifts of laborers in the rice fields while weeding the young crop. Constant immersion of the feet and hands in water destroys the natural resistance of the skin and the needles of the weeds produce pricks which readily become infected through scratching. The irritation is intense and there is severe pain heat, and tension in the affected parts. The lesions begin as large erythematous patches, which soon

become edematous, and the site of pustules. In the more severe cases vesicles and phlyctenules are formed which easily become pustular and break down leaving erosions. The affection clears up promptly when work is stopped especially in the early stages.

Prevention is easily accomplished by the use of cloth leggings and the application of a protective coat of grease to the exposed parts of the skin.

Hydrophyllaceæ (Water-leaf Family)
Phacelia crenulata
Phacelia brachyloba
Phacelia grandiflora
Phacelia minor
Phacelia pedicellata (Muenscher)
Hypericaceæ (St. John's Wort Family)
Hypericum perforatum (Muenscher)
Hypericum crispum

The plants contain two fluorescent chemicals, hypericin and hypericum red which cause photosensitization and they also contain a volatile oil.

Iridaceæ (Iris Family)
Iris versicolor.—Blue flag. (Muenscher)
Iris florentina.—Orris.

The powder of iris florentina orris root has been reported as causing dermatitis when used in cosmetics. The essential oil is the irritant.

Lauraceæ (Laurel Family)
Sassafras varifolium.—Tree. (Weber)
Sassafras albidum
Cinnamomum zeylanicum.—Cinnamon tree.

Dwarf Laurel (*Daphne mezerium*).—The bark of this European shrub which is used medicinally as a diaphoretic diuretic and stimulant can cause vesicular dermatitis.

Cinnamon.—True cinnamon is derived from the bark of *Cinnamomum zeylanicum* (Order of *Lauraceæ*) while the substance *Cassia* comes from other varieties of *Cinnamomum*. Volatile oils of both cinnamon and cassia have for their chief constituent *cinnamic aldehyde* which is an irritant powerful enough to blister the tongue. The cinnamon powder in ordinary use for bakery products, confectionery, etc., contains but a trace of the essential oil and may often escape suspicion in a case of contact dermatitis.

Tulipan observed a case of dermatitis in a baker who gave negative reactions to the trichophytin test and to patch tests with all the materials of his trade except cinnamon which produced a marked reaction. When first seen the eruption was of eight weeks standing and consisted of pin-head sized vesicles on an erythematous base with fissuring and crusting. The lesions were confined to the palms, due to the fact that the patient scooped up the powder with his hands to spread on pie crusts.

J. C. White reported an inflamed vesicular eruption on the hands

of a girl who dipped toothpicks into *oil of cassia* to give them an agreeable flavor

The risk to pastry cooks and confectioners from cinnamon and also from oil of cassia, which is sometimes used as a substitute for cinnamon is stressed because of the fact that little mention has been made of these substances in the literature, and their etiological significance in cases of contact dermatitis may easily be overlooked

Liliaceæ (Lily Family)

Veratrum viride.—American or green hellebore. (Muenscher)

Urginea scilla.—Sea onion squill.

Nolina texana.—Bunch grass. (Muenscher)

Lilium superbum. (Weber)

Lilium longiflorum (Weber)

Allium sativum.—Garlic. (Weber)

Tulipa gesneriana.—Tulip.

The bulb stem and flower cause a dermatitis among florists called tulip fingers.

Colchicum autumnale.—Crocus.

Hyacinths (*Hyacinthus* Lily Family).—Florists may contract an itching and squamous dermatitis of the hands with deep fissures especially beneath the nails while sorting defective hyacinth bulbs from which the juice is oozing Cases have been reported among dealers and clerks in seed stores who handled and cleaned the bulbs. Patch tests with the macerated pulp especially that of the Dutch hyacinth have produced positive reactions in five minutes in one patient together with pruritus of the ears.

Tulip bulbs have been held responsible for painful lesions with desquamation of the skin localized entirely under and around the fingernails without affecting the nails themselves. The condition is known in the industry as tulip fingers. In the cases reported the eruption has appeared in a few of the sorters and packers in large exporting firms a few days after beginning work. The condition has been observed to be most frequent among workers with long fingernails.

Extremely painful lesions occur among workers in the English tulip fields, with seasonal recurrence Homer has observed eruptions from contact with the juices of tulip stems and suggests that a lime salt may be responsible. She finds that the application of ointment around the nails and keeping the nails well trimmed are both preventive and curative. The use of finger cots when working also affords protection.

In 1930 Caulfield reported a case of "tulip fingers, in which intramuscular injection of the ether-soluble portion of the bulb in corn oil prevented recurrence for the first time in five years.

Medicinal Squill (*Scilla maritima* Lily Family).—The juice of the squill has been known to produce dermatitis. Some authorities believe that the juice of *Scilla rubra* is a cutaneous irritant to every one while contact with the leaves irritates only sensitized individuals.

Linaceæ (Flax Family)

Linum usitatissimum —Flax (Weber)

Linseed.—Employees in contact with linseed in plants where the oil is extracted and in paint factories sometimes develop a mild itchy scaling pink rash on the hands and arms, and occasionally on the face and legs. Longshoremen unloading the grain have also been affected chiefly by Indian linseed but also by grain imported from South America. The etiology is not certainly determined In Schwartz's cases, acari have been implicated (see Insects and Animal Parasites) Pedley suspects the burlap sugar bags in which the linseed is shipped Aitken has found the patch tests with the linseed itself to give a positive reaction in some cases accompanied by exacerbations of the original lesions.

Loasaceæ

Mentzelia ornata.—Prickly haired herb

Mentzelia oligosperma (Muenscher)

Lobeliaceæ (Lobelia Family)

Lobelia inflata —Indian tobacco (Weber)

Loganiaceæ (Logania Family)

Gelsemium sempervirens —Yellow jessamine

Malaceæ

Cotoneaster microphylla (White.)

Malpighiaceæ

Malpighia urens (Weber)

Malvaceæ (Mallow Family)

Hibiscus esculentus —Okra (Weber)

Meliaceæ (Mahogany Family)

Andiroba or Carapa —Tree

Chloroxylon swietenia —Tree

Dysoxylon Muelleri —Tree

Dysoxylon richii.—Tree

Swietenia mahogani.—Tree

Swietenia senegalensis —Tree.

Menthaceæ

Leonurus cardiaca —Motherwort. (Muenscher)

Mentha citrata —Bergamot mint.

Mentha citrata contains a fragrant lemon scented oil which may cause photosensitization

Mimosaceæ (*Leguminosæ*) (Pulse or Bean Family)

This is a large family and many of the members not only cause dermatitis but contain alkaloids which are systemic poisons. The Lupines contain alkaloids lupinine lupanine sparteine, spathulatine. The Astragali or loco-weeds contain barium

The following members have been reported as causing dermatitis

Acacia harpophylla —A small tree.

Acacia melanoxylon —Tree.

Inga vera —Tree

Lysiloma sabicu — Tree

Medicago denticulata —Bur clover

Medicago hispida

Prosopis juliflora.—Mesquite tree.

Pithecolobium arboreum

Pithecolobium filicifolium.

Psoralea esculenta

Trifolium hybridum.—Alsike clover

May cause sore mouth and dermatitis on legs and body of cattle.

Cowhage (*Mucuna pruriens*).—The hairs of this plant contain sebacic acid and is said to cause an urticarial rash among laborers in the sugar cane fields.

Beans (*Phaseolus vulgaris* including kidney beans, string beans, and pole beans, *Leguminosae*) have been known to produce recurrent erythema among hypersensitive workers in preserving and canning factories, to such an extent that in some countries such persons are not allowed to work in the factories.

Creosote Bush (Bean-caper Family).—Smith reports dermatitis caused by this bush.

Senna (*Cassia acutifolia Leguminosae*).—Contact with this plant has been known to provoke a severe and painful dermatitis in sensitized persons, covering the face, hands, and genitals. The *saponin* in the leaves is believed to be the toxic agent.

Moraceae (Mulberry Family)

Chlorophora tinctoria (*Moulewood*).—Tree, yields yellow dye.

Chlorophora excelsa (*Moulewood*).—Tree, yields yellow dye.

Fig Tree (*Ficus carica*).—The sap from the cut shoot or leaf stalk of this tree is very irritating and may cause a rash, which soon disappears but leaves a permanent bronze-colored pigmentation of the skin without elevation or hyperkeratosis. Kitchevatz considers this a phenomenon of photosensitivity claiming that the supposed toxic substances of the plant cannot produce dermatitis without the action of light, but merely act as photocatalyzers. Washing the hands immediately after contact is said to prevent the discoloration.

Various parts of the tree are poisonous, but the toxicity appears to vary from tree to tree and from season to season, so that the risk is unpredictable. Packers of dried figs in California are subject to irritation from the milky juice containing a protein enzyme of the stem and the latex tubes of the branches, as well as from the skin of the fruit. Some workers employed in picking fresh figs complain of stinging sensations and blisters having a serosanguinous discharge, which occur three or four hours after contact.

The fruit and leaves of the wild fig often produce dermatitis among gardeners who handle them.

Aleixo reports 5 cases of dermatitis with pigmentation in South America among workers who come in contact with macerated fig leaves used for making a hair wash. Other cases have been observed among confectionery makers and one occurred in a housewife after cooking some fresh figs. In some cases, sensitivity has been acquired after working with figs for a number of years. Popoff and Bondiner consider the lesion clinically and pathogenically analogous to the

dermatitis bullosa striata of Oppenheim and believe it to be an allergodermia of strongly local character rather than a toxidermia.

Osage Orange (*Maclura pomifera*) may cause dermatitis by pricks from its spikes or by its irritant milky sap.

Sisal Juice contains lactic acid and both sisal and hehequen leaves contain an irritating sensitizing principle.

Musaceae

Bananas (*Musa sapientum*).—A contact dermatitis of allergic character may be produced by the uncontaminated pulp of the banana. The sensitizing agent of the pulp and the rind may be different and patch tests with both should be made in cases of dermatitis among handlers of this plant to determine the presence of allergy. It has been suggested that insecticides and disinfectants used on the banana tree may account for a contact dermatitis occurring among workers handling the stalks and rinds.

One cause of dermatitis among banana handlers is said to be the coarse *jute* twine used for hanging the bunches.

Myrtaceae

Melaleuca leucadendron.—Cajuput tree, punk tree, swamp tea tree. Yields oil of cajuput.

Sonneratia apetala.—Kambala wood tree.

Eucalyptus macrorrhyncha.—Tree.

Eucalyptus hemiphloia.—Tree.

Eucalyptus globulus.—Blue gum tree.

Naiadeae

Naias major.—Pond weed.

Naias minor.

Oenotheraceae

Oenothera biennis.—Evening primrose. (Weber.)

Oleaceae

Jasminum grandiflorum.—Jasmine.

Syringa vulgaris.—Lilac.

Orchidaceae (Orchid Family)

Vanilla planifolia.—Tropical orchids produce beans from which vanilla is extracted.

Irritations occur from mites which infest the pods. Workers putting sticks of vanilla into alcohol develop erythema and edema of exposed parts. Cases of dermatitis from vanilla flavoring have been reported in candy factories. A young Hindu developed a pustular rash on the arms, face, abdomen, and legs after handling vanilla, and a vendor developed puffiness of the face, edema of the eyelids, and inflammation of the wrists and arms.

After the possible action of molds or acari has been excluded it appears probable that the oily juice of the pods is responsible for the dermatitis. Its action is increased by the presence of alcohol or cardol (from the cashew nut), which is sometimes used to color and preserve the pods. Vanillism is a fairly common affection in the perfume and confectionery industry.

Papaveraceæ (Poppy Family)

Argemone platyceras.—Prickly poppy. (Muenscher.)

Chelidonium majus.—Celandine. (Muenscher.)

Sanguinaria canadensis.—Bloodroot. (Muenscher.)

Phytolaccaceæ (Pokeweed Family)

Phytolacca americana.—Pokeweed.

Pinaceæ (Pine Family)

The woods of several members of the pine family have caused dermatitis.

Arbor Vitæ (*Thuja occidentalis* and *orientalis*).—These shrubs occasionally induce cutaneous eruptions, chiefly among gardeners. A severe rash of the hands and face from crushing arbor vitæ branches has been reported.

Chamæcyparis lawsoniana.—Tree.

Cupressus lawsoniana.—Tree.

Juniperus virginiana.—Red cedar tree.

Pinus pinaster.—Tree.

Pinus strobus.—Tree.

Sequoia gigantea.—Tree.

Platanaceæ

Platanus orientalis.—Sycamore tree.

Platanus acerifolia.

Platygyna pruriens.—Wild tropical vines with irritant hairs. (Weber.)

Tragia volubilis.—Wild tropical vines with irritant hairs. (Weber.)

Poaceæ

Oryza sativa.—Rice.

Phleum pratense.—Timothy. (Weber.)

Syntherisma sanguinalis.—Crab grass.

Polygonaceæ (Buckwheat Family)

Coccoloba uvifera.—Sea grape. Small tree.

Fagopyrum esculentum.—Buckwheat.

Fagopyrum tataricum.—Buckwheat.

Fagopyrism is caused by the action of buckwheat flour on the skin, particularly when followed by exposure to ultra violet rays. It is a photosensitization.

Polygonum spp.—Knotweeds or smartweeds.

Rheum rhaponticum.—Rhubarb. (Muenscher.)

Rumex acetosa.—Docks. sorrel.

Rumex acetosella.

Rumex crispus.

Primulaceæ (Primrose Family)

Primrose (*Primula obconica*).—In some persons the slightest contact with the hairy parts of this plant is enough to cause a dermatitis. The glands of the plant secrete a toxin in the form of a syrupy yellowish-green juice which is insoluble in water and sticks to every object it touches and the damp pollen of the variety *farinosa* is said also to convey the irritant. Thus irritation may occur not only from touching the plant, but from being in its vicinity without direct

contact. Gardeners agricultural laborers, and florists frequently are affected by it Lehman states that 30 per cent of gardeners are affected by the plant while Bloch places the figure at 40 to 50 per cent. Milkers sometimes develop a rash attributed to handling the udders of cows who have passed through fields of primroses covered with dew

When irritation occurs through direct contact some authorities consider the crystals of oxalate of calcium contained in the plant to be the cause of the rash while others hold that these crystals merely convey the irritant

The incubation period varies from a few hours to several days. The typical rash consists of numerous shiny red punctiform papules about the size of a needle s eye and closely packed together Small vesicles and large blisters may develop. Subjective sensations are smarting and itching

Anagallis arvensis —Scarlet pimpernel (Muenscher)
Primula auricula
Primula cortusoides
Primula farinosa
Primula malacoides
Primula mollis
Primula sinensis (Muenscher White.)

Proteaceæ
Grevillea banksii —Kahili flower
Causes dermatitis similar in character to poison ivy

Pyrolaceæ (Wintergreen Family)
Chimaphila umbellata —Pipsissewa
Chimaphila maculata —Princess blue (Weber)

Pucciniaceæ (Rust Fungi)
Puccinia graminis —Wheat rust.

Rhamnaceæ (Buckthorn Family)
Ceanothus velutinus (Weber)

Rosaceæ (Rose Family)
Agrimonia eupatoria
The juice of the leaf causes blistering of the skin

Rubiaceæ (Madder Family)

Ipecacuanha (*Cephælis ipecacuanha*) —A chemist a boiler and a sorter are reported to have suffered an eczematous rash from contact with the alkaloid *emetine* while making a preparation of ipecac.

Ranunculaceæ (Crowfoot Family) —Almost the whole order of Ranunculaceæ possess toxic juices capable of causing inflammation and blistering if rubbed on the skin and may be a risk to florists, gardeners, and field laborers. The order includes

The **Blister Plant** (*Ranunculus acris*) causes redness, pruritus, and vesiculation in sensitized persons. Its active principle is anemonin ($C_{10}H_8O_4$) a crystalline compound closely related to cantharidin

Aconitum napellus —Monk s-hood (Weber)
Actæa alba —Baneberry (Weber)
Actæa spicata (Weber)

Anemona patens.—Windflowers. (White.)
Anemona quinquifolia.—Windflowers.
Contains an acrid alkaloid anemonine causing blisters.
Aquilegia spp.—Columbine.
Caltha palustris.—Marsh marigold.
Clematis virginiana.—Virgin's bower.
Delphinium ajacia.—Larkspur.
Delphinium consolida.—Larkspur.
Helleborus niger.—Christmas rose.
Hepatica.—Liver leaf.
Hydrastis canadensis.—Golden seal.
Paeonia spp.—Peony.
Pulsatilla vulgaris.—Pasque or Easter flower.
Contains an acrid alkaloid anemonine.
Ranunculus spp.—Buttercups.
Thalictrum spp.—Meadow rue.

Rutaceae.—Members of the Rue family such as the common rue (*Ruta graveolens*), *Ailanthus-glandulosa*, *Pilocarpus pennatifolius*, *Haplophyllum tuberculatum* and *Rue montana* have been reported as producing irritation apparently by contact with a volatile toxin. In 1937 Gummer and Dexter added another variety to the list, *i. e.*

The **Gas Plant** (*Dictamnus albus*), a common plant in American gardens, according to these authors may cause an affection similar to berlocque dermatitis in that the toxic action takes place only upon exposure of the skin to sunlight after the plants have been handled. They describe 2 cases, which appear to be the only ones thus far recorded in the literature.

After working with these plants in hot sunshine, the patients developed dusky red patches on the skin with bullae about the size of a navy bean, either discrete or in groups of two or three. Subjective symptoms were notably slight. After the disappearance of the eruption a discoloration of the skin persisted for a number of weeks.

Covered patch tests with the pods and juices from other portions of the plant produced no reaction, but when the pods were rubbed on the skin and the part exposed to sunshine erythema resulted in sixteen hours and was followed by bullae the next day. The substitution of ultra-violet rays for sunlight brought no reaction.

Oranges and Lemons, Tangerines, etc. (Citrus Fruits of the *Rutaceae* Rue Family).—The essential oil limonene ($C_{10}H_{16}$), a terpene found in the rinds of these fruits, frequently produces dermatitis in sensitive persons working with them. Citral ($C_{10}H_{16}O$), various aldehydes, geraniol and linalool are other irritants contained in citrus peel. Employees in factories making preserves, confectionery, etc., and in perfume factories (see Cosmetics) may be affected from this source. The left hand, which holds the fruit for peeling, is usually the site of the lesion, but the oil may also be carried to the face, producing pustular eruptions.

In 1930 a number of cases were reported from handling bitter

oranges. The symptoms observed were severe pruritus, followed by edema, and often by vesicles and crusting. Constitutional symptoms sometimes accompanied the cutaneous eruption. (Fig. 93.)

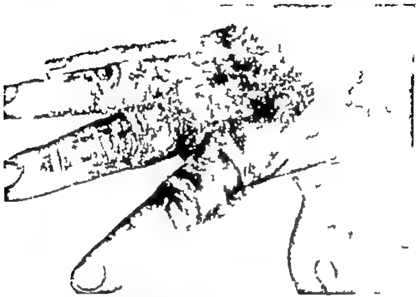


FIG. 93. Occupational dermatitis in a fruit dealer due to oil of oranges. Positive patch test. Successful desensitization. (Case of Dr. B. M. Kesten, Vanderbilt Clinic, Columbia University, New York.)

Longa in 1927 studied a case of dermatitis caused by the juice and essence of lemons, in which the skin assumed a whitish hue with an eruption that was extremely painful and was exacerbated by cold weather. The interdigital surfaces, digital folds, and periungual grooves were attacked. Warts, when present, became necrotic.

The thorns of certain citrus trees cause pricks and wounds on pickers.

Fagara flava

Zanthoxylum flavum

Zanthoxylum cribrosum

Salicaceæ (Willow Family)

Populus candicans.—Balm of Gilead

Sapindaceæ (Soapberry Family)

Sapindus drummondii.—Soapberry

Dermatitis occurs from handling the fruits.

Sarcocephalus diderrichii

Trees and vines in the Belgian Congo

Scrophulariaceæ (Figwort Family)

Verbascum thapsus.—Mullein. (Weber.)

Digitalis purpurea.—Foxglove. (White.)

Digitaria sanguinalis.—Crab grass. (Shelmire.)

Simaroubaceæ (Quassia Family)

Ailanthus altissima —Tree of Heaven.

Ailanthus glandulosa —Tree of Heaven.

Solanaceæ (Nightshade Family)

Deadly Nightshade (*Atropa belladonna*) —The whole of this plant is poisonous. Persons handling the berries have developed vesicopustular eruptions on the face with disorders of accommodation The sap causes edematous erythema with vesicles on the face and hands of laborers cutting down the branches. The active principle *atropine* sometimes affects the skin of druggists and chemists.

Tomatoes (Nightshade Family) prove irritating to some persons who gather them when they are wet with dew or when the vines have become rank. Workers in an Italian canning factory are reported to have developed eczema of the hands from the citric and malic acids contained in the juice. The trouble is reported to have been stopped by rinsing the hands from time to time in a weak solution of sodium hydroxide.

Potato (*Solanum tuberosum* Nightshade Family) —The plant of the common potato is said to cause dermatitis, but only during certain phases of its blossoming

Red Pepper Cayenne (*Capsicum annum* Nightshade Family) —The fruit or sap of the plant applied to the skin has produced erythematous and bullous dermatitis.

Tobacco (Nightshade Family) —A case was reported in which blisters occurred on the hands, face and neck of a woman sorting pressed tobacco leaves in a cigarette factory She recovered when she left work but suffered a recurrence on her return. (See Tobacco Manufacture.)

Henbane (*Hyoscyamus niger* Nightshade Family) —Inunction of the skin with the oil of this plant causes a painful blistering

Datura stramonium —Jimson weed.

Hyoscyamus niger

Sterculiaceæ (Cola-nut Family)

Pterospermum spp (White.)

Taxaceæ (Yew Family)

Taxus baccata.—English yew tree.

Thymelaeaceæ (Mezereum Family)

Daphne mezereum.—Daphne. (Muenscher)

Dirca palustris —Leatherwood moosewood

Tiliaceæ (Linden Family)

Jute (the fibers of *Corchorus olitorius* and *capsularis* Linden Family) —Jute dermatitis is well known According to Broers, it is a folliculitis due to the occlusion of the sebaceous glands by the plant fibers. This occurs in laborers who wash the jute plants. Swelling and inflammation occurs from handling jute and is attributed to the soaps and oils used in processing it, although allergy to the plant itself is said to play a rôle in it.

Basswood, the American linden has been reported to have caused dermatitis.

Tropæolaceæ

Tropæolum majus.—Nasturtium (Weber.)

Umbelliferæ (Parsley Family)

Celery (Apium of the *Umbelliferæ*).—The juice of common garden celery frequently causes a mild erythematous vesicular or papular rash in sensitive persons handling it. Market gardeners who cut celery may be affected and Henry has observed 23 cases in a canning factory. He believes the chief irritant to be *limonene*, a hydrocarbon of the terpene series (see also Oranges and Lemons, p. 585) contained in the juice. Pure petrolatum or other protective oil applied to the exposed parts of the skin is an adequate preventive.

Parsnips (*Pastinaca sativa*).—Edel reported that erythematous and sometimes vesicular eruptions occurred in one-third of 60 soldiers engaged in weeding a field of parsnips, after an incubation period of forty-eight hours. The toxicity of parsnip juice varies with the seasons and with the amount of moisture. Edel rubbed the juice of this plant on his hands and produced an inflammation lasting six days.

Dicker described the case of a field laborer who developed a case of dermatitis bullosa after gathering parsnips for two days. It began with pain in the hands and forearms, and was followed by itching, the formation of bullæ, erythema and edema. Several peasants were similarly affected while doing the same work in fields near Geneva, and the author attributed the eruptions to the volatile oils contained in the vegetable. The plants appeared to be most toxic when wet. It is also a photosensitizer.

The **Cow Parsnip** (*Heracleum lanatum*) contains in its root and rind an acrid sap sufficiently strong to inflame and ulcerate the skin.

Wild Carrot (*Daucus carota*).—Spitzer reports dermatitis due to wild carrot. He considered it to be due to mechanical irritation by hairs of the plant. Peck reported dermatitis from the domestic carrot and said it was allergic.

Cow Parsley (*Angelica*, *Umbelliferæ*).—This plant is used in the confectionery trade. Its active principle, angelic acid $C_5H_8O_2$, is capable of producing extensive dermatitis with blistering among sensitive employees.

Urticaceæ (Nettle Family)

Hops (*Humulus lupulus*).—The great majority of plants belonging to the Nettle Family are said to be both narcotic and toxic. Contact dermatitis from hops, first described by Dale in 1693, is still a common affection among hop pickers. The rash consists of an itching papular eruption on the face, hands, and forearms, and occasionally even on the legs. The cutaneous disorder is frequently accompanied by conjunctivitis and synovitis, called "hopper's gout."

Hemp (*Cannabis indica*).—A number of cases of dermatitis have been observed from contact with hemp in various forms. Bundles of hemp dried in the sun after being removed from the macerating basins give off a dust full of fine particles from the "bast" fibers. This dust affects some of the workmen who carry the bundles with

intense pruritus which is frequently followed by secondary infections. A rope maker is reported to have incurred dermatitis from sorting Indian hemp and a woman working in a hemp field all day is reported to have developed swelling and redness of the skin over her entire body with edema of the eyelids, necessitating a plastic operation. In the hemp industry workers who pull off the leaves of the plant may suffer from a generalized erythema caused by the dust and aggravated by perspiration and the physical movements peculiar to the work.

Nettles.—The stinging nettle (*Urtica dioica*) contains formic acid. The hairs of the plant cause mechanical injury to the skin and facilitate absorption of the irritants which produce cutaneous irritation. The tropical stinging nettle (*Laportea gigas*) which is said to be more poisonous than those of the temperate zones, causes a vesicular erysipelatous eruption of the skin.

Iranoki (*Laportea pterostidua*).—Uchida and Norikane report dermatitis due to this plant which is indigenous to Formosa. The active agent is formic acid which is present in the sting-hairs of the plant.

Urera spp. (Weber.)
Urtica spp.
U-artigiulla
Laportea canadensis.—Wood nettle.
Tragia volubilis.—Twining cow itch.

Verbenaceae (Verbena Family)
Tectona grandis.—Teak tree

Vitaceae

Grapes.—Anderson reported a case of multiple sensitization to this fruit. The patient had squeezed by hand a large quantity of Concord grapes for making grape juice and had eaten some of the marmalade and the fresh grapes.

Virginia Creeper or Woodbine (*Ampelopsis quinquefolia. Vitaceae*).—This vine is a native of the United States and its foliage, especially in the autumn frequently causes a smarting of the skin in gardeners. Cases have been observed in which a vesicular eczema has resulted from contact with the plant.

Zygophyllaceae
Tribulus terrestris.—Puncture vine. (Muenscher.)
This plant is a photosensitizer.

Photosensitizing Plants.—Some plants have the property of making the skin hypersensitive to sunlight, so that dermatitis results upon exposure to ordinary daylight. Contact of the skin with these plants or ingestion of them will produce photosensitization. Animals feeding upon them will develop photosensitization. The following is a list of the plants known to have photosensitizing properties.

Lechuguilla (*Agave lecheguilla*) contains a photodynamic agent toxic to animals exposed to direct sunlight after feeding

Bergamot (*Citrus bergamia*) the fruit of the tree called the bergamot orange furnishes an oil used in perfumery which causes photosensitization upon contact (Berlocque dermatitis)

Wild Carrot (*Daucus carotus*) causes photosensitization upon contact.

Gas Plant, Fraxinella (*Dictamnus alba*) —Parts of the skin in contact with the seed-pods may become photosensitive and develop vesicles upon exposure to light. The eruption may leave the skin pigmented for several weeks.

Buckwheat (*Fagopyrum esculentum*) and **India wheat** (*Fagopyrum tataricum*) cause photosensitization in animals with unpigmented skin after eating Some humans are also susceptible after eating buckwheat. Rarely does contact with buckwheat leaves cause dermatitis.

Figs (*Ficus carica*) —Contact with the milky sticky sap exuding from the stem of the fig and the fig tree causes photosensitization in some people.

St. John's Wort (*Hypericum perforatum*) —Goat weed and hypericum crispum cause photosensitization dermatitis on animals, especially on unpigmented portions of the skin after ingestion Hypericin and hypericin red two fluorescent compounds are the active ingredients.

Bur Clover (*Medicago denticulata*) causes photosensitization after ingestion

Bunch Grass (*Nolina texana*) causes photosensitization in animals after ingestion.

Parsnip (*Pastinaca sativa*) —Some people develop dermatitis after contact with the flowers or leaves especially after bathing on sunny beaches.

Lady's Thumb (*Polygonum persicaria*) causes photosensitization in animals after ingestion. **Water Pepper** (*Polygonum hydropiper*) may cause dermatitis among some humans.

Horsebrush (*Tetradymia glabrata*) and **Spineless Horsebrush** (*Tetradymia canescens*) causes photosensitization in animals after ingestion

Puncture Vine (*Tribulus terrestris*) causes photosensitization among sheep after ingestion

Alsike Clover (*Trifolium hybridum*) causes photosensitization in animals after ingestion and dermatitis in some humans after contact.

WOODS

Dermatitis from woods is fairly frequent among carpenters, sawyers, woodsmen lumber yard men wood polishers cabinet makers, furniture manufacturers ship builders, and airplane makers. The sawdust the sap polishings, or oil of the wood are the irritants. (Fig 94.)

Woods from foreign localities or woods not handled before are the ones that usually cause dermatitis.

The workers become affected several days after beginning to

work with the new wood It is usually a sensitization dermatitis, only a few of the workers being affected The majority of those affected become hardened develop a hyposensitization after they recover A small percentage of those affected remain sensitized

FIG. 91 —Dermatitis from rosewood used for knife handles. Four days after onset. Genus dalbergia.

The majority of the cases are mild consisting of papules and vesicles on the hands and arms. Such cases may continue at work, using protective sleeves protective ointments, and frequent cleansing of hands and arms. The few severe cases in which the face eyes, and covered parts of the body are affected should stop work until they recover They should then return to work, using protective clothing, protective ointments and frequent washing of the hands, arms, and face. Many of such workers will have developed a hyposensitivity but some of them may again develop dermatitis. These should be permanently removed from contact with the wood

The treatment of dermatitis from woods is the same as from other plants namely for severe cases mild wet dressings in the acute stages and mild ointments as the acute stage subsides. In mild cases where there is not much edema and not many papules or vesicles, those on the hands, arms and legs can be rubbed vigorously with gauze soaked in ethyl alcohol so that the tops of the smaller

vesicles are abraded Large vesicles can be opened with a sterile knife. This should be followed by applying a wet dressing of a 10 per cent aqueous solution of tannic acid for thirty minutes. The treatment should be repeated every six hours to get the new crops of vesicles. Usually three to four treatments are sufficient to allay all itching and to "scab" over the sites of the vesicles.

IRRITANT WOODS

ANACARDIACEÆ — Poison Ivy Family

- Aroeira (Brazil) produces a morbilliform rash
- *Dysoxylon richii*
- *Dysoxylon muelleri*
- *Glauta anacardiacea*
- *Melanorrhœa anacardiacea* — Singapore mahogany
- *Melanorrhœa maingaya*
- *Mangifera indica* — Mango tree
- *Mangifera kemanga* — Mango tree
- *Melanochylla auriculata*
- *Lithræa caustica* or *venenosa* (Chili) Litre

ANONACEÆ

- Lance wood of Cuba, Brazil, and Guiana Used for wagon shafts fish poles spear shafts

APOCYNACEÆ — Dog bane family

- *Cameraria latifolia* — Bastard manchineel
- *Hippomane mancinella* Manchineel Manzanillo The tree has an acrid milky sap Beach apple of Canal Zone

BETULACEÆ — Birch Family

- Alder tree—produces an eruption somewhat similar to lupus erythematosus
- Birch tree

BIGNONIACEÆ

- *Jacaranda* (Several trees of the family Leguminosæ are also called jacaranda)
- *Jacaranda cærulea* (This tree is sometimes called boxwood)
- *Palisander* (Some rosewoods of the family Leguminosæ are also called palisander)
- *Ipe peroba* (Brazil)
- *Peroba amorella* (Brazil) contain the irritant aspidospermin

CHENOPODIACEÆ

- Bassia wood — Butter tree
- *Bassia parkii* (West Africa) — Illupi
- *Bassia latifolia* (West Africa) — Mahwa
- *Bassia longifolia* (West Africa)

COMPOSITÆ — Composite Family

- Macassar wood (The sap of tree is used by the Malays as an arrow poison)

CONIFERAE OR PINACEAE — Pine Family

Cypress	
Silver fir	Abies alba
Silver spruce	
Hemlock spruce	
Norway spruce	
Pine	Pinus maritimus
Redwood	Sequoia sempervirens (California)
Juniper	Juniperus virginiana
Turpentine tree	Pistachia terebinthus
Red cedar	

All these trees contain turpentine and resin acids.

CORNACEAE — Dogwood Family

Cassina aculeata	Australian dogwood
Piscidia erythrina	West Indian dogwood used as a fish poison
Florida dogwood	Sometimes called Florida boxwood

EUPHORBIACEAE — Spurge Wort Family

These trees have leaves with prickles and hairs as well as an irritant poisonous sap which is sometimes used by the natives as an arrow poison.

Hippomane mancinella	Manzanillo, Manchineel Beach apple

This tree has a milky acrid sap which is used as a fish poison. The wood choppers burn off the bark before chopping down the tree, in order to destroy the poison.

Excoecaria agallocha (Asia and Australia)	Blinding tree
Aura crepitans	
Jatropa curcas L	

FABACEAE

Cladrastis lutea	Yellow wood

May also be called Florida boxwood

FAGACEAE — Beech Family

Beech	
Oak	Quercus robur
Chestnut	Castanea
Andiroba	Andira araroba Aquiar This tree is the source of chrysarobin

LAURACEAE — Laurel Family

Embuia nectandra	Brazilian walnut

LEGUMINOSAE — Bean Family

Rosewood	Dalbergia
Cavinna wood Brazilian rosewood	Amerimnon nigrum
Botany wood	
Coco bolo	
Cocus wood Granadilla wood	Brya ebenus W Indies Used for flutes causes cheilitis
Palisander wood Jacaranda wood Violet wood	Trees of the family Bignoniaceae May also be called by these names
Mesquite wood	Prosopis juliflora

Meliaceæ — Mahogany Family

These woods are used in making fine furniture and in ship building. The raw wood stains the skin a brown color and contains an irritant alkaloid chloroxylonine

Mahogany	(West Indian)
Mahogany	(Honduras) Often called Tobasco mahogany
Mahogany	(African)
Boxwood	(African and Maracaibo) Buxus sempervirens
Boxwood	Gonioma kamassi causes yellow pigmentation, camphor odor to the breath headache dilated pupils and slow pulse as well as dermatitis.
Boxwood	(West Indian) Gossypiospermum praecox
Satin wood	

Mimosaceæ — Mimosa Family

Acacia melanoxylon	Black wood
Acacia harpophylla	(Australia) Causes "Brigalow itch" among cabinet makers
Lysiloma sabicu *Sabicu morura*	(West Indies and Central America) Sabicu wood. Horse flesh mahogany used for ship building
Pithecolobium arboreum	Used for making bobbins

Moraceæ — Mulberry Family

Chlorophora excelsa *Chlorophora tinctoria*	Iroko wood Moule wood Old fustic
Maclura pomifera	Osage orange. Bow tree Has milky irritant sap

Myrtaceæ — Myrtle Family

Eucalyptus hemiphloia	
Eucalyptus maculata	
Eucalyptus macrorhyncha	
Eucalyptus globulus	Blue gum tree
Backhousia australis	Australian lance wood
Curtisia faginea	Cape lance wood The lance woods are used for wagon shafts, fishing rods, whip handles, spear shafts
Kambala wood	
Punk tree	
Cajaput tree	

Rutaceæ — Rue Family

Fagara macrophylla	(Gabon and Cameroons) Olon wood may also be called satin wood

Styracaceæ — Storax Family

Liquidambar styraciflua	Sweet gum

Taxaceæ

Taxus baccata	English yew Bow tree
Taxus cuspidata	Japanese yew
Tiliaceæ	American Linden Bass wood

Verbenaceæ

Tectona grandis	(East Indies) Teak Contains irritant unsaturated resinic acid

ZYGOPHYLLACEÆ	
Guaiacum officinale	Lignum vitæ tree

Miscellaneous Woods Reported to Have Caused Dermatitis

Amber wood	
Comocladia dentata	
Ebony	Diospiros ebenus. Also the black heart of several tropical hard wood trees
Ixodes ricinus	
Jacareuba	
Lemon wood	(New Zealand) Pittosporum eugenioides, the hedge laurel or tarata. Also called by the settlers, maple, turpentine and white mapan. A small evergreen with fragrant yellow flowers
Moa wood	Flindersia australis
Muirapenima	
Red gum	
Red quebracho	Schinopsis lorenzii or loxopterygium lorenzii Contains a bitter poisonous alkaloid quebrachamin. The dermatitis it causes is called "paag"
Stink tree	Orixa japonica. Thumb Grows in Japan and is used as fertilizer The following trees are also called stink woods Ocotea bullata or South African teak Zieria lanceolata (Tasmania) Fœtidia mauritiana (Mauritius) Nyssa sylvatica (Southern United States)
Tagayasan wood (Japan)	Contains chrysophan-hydroanthon allied to chrysarobin. Discolors the skin, causes dermatitis, conjunctivitis and keratitis.

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CHAPTER XXXIX

DERMATOSES CAUSED BY ANIMAL PARASITES

INDUSTRIAL hazards may be caused by a large number of organisms ranging from mites to winged insects, and including spiders and centipedes.

MITES

Acari or mites, are minute animals related to spiders. They are parasitic on man and animals and are capable of producing various lesions of the skin. Mites of the genera *Sarcoptes Demodex Leptus Trombidium, Trombicula Dermanyssus Pediculoides Tyroglyphus Chorioptes Otodectes* and *Chenudocoptes* are the chief acari producing cutaneous irritation in man.

Scabies.—This is considered to be the only real skin disease produced by mites in human beings, the other eruptions being more or less transitory It is due to the *Sarcoptes scabei* or *Acarus scabei*. The female penetrates the skin and deposits her ova in the stratum corneum The larvæ hatch out in from four to eight days and burrow through the horny layer setting up intense pruritus, inflammation and vesicles which may be followed by such manifestations as papules, pustules, crusts excoriations, and pigmentation The burrows, or galleries, usually appear as whitish or yellowish slightly arciform thread-like depressions covered with dark points but sometimes the cuniculus forms an elevated ridge with white dots running along its summit.

The areas attacked are, in the order of frequency the hands particularly between the fingers, the wrists, the axillæ the breasts of women buttocks in children, and the penis and scrotum in men Scabies seldom attacks the face. Itching is particularly marked at night after going to bed many patients being untroubled in the day but tormented at night.

The disease is contagious and occurs chiefly among persons living under crowded unhygienic conditions. Tailors, bakers, and shoemakers who work in bad surroundings are subject to infestation with these mites. Scabies is prevalent among soldiers in time of war and among the civilian population following wars or on the return of soldiers from the field Members of the theatrical profession and others who travel from place to place chambermaids, doctors, nurses, midwives, hospital orderlies, and social workers may contract the disease in the course of their employment Farmer's itch lumbermen's itch miner's itch and prairie itch which are common in the Northwestern States are believed to be true forms of scabies.

The disease is quickly curable however long the duration but the eczema of the skin induced by it often requires some time to disappear

Treatment.—The patient should take a hot cleansing bath and then rub a sulphur ointment thoroughly into the affected areas. We prefer Unguentum Wilkinson consisting of

Sulphur sublimat.	½ oz.	(15 gm.)
Ol. rusci	½ oz.	(15 gm.)
Cretae preparatae	1 dram	(4 gm.)
Saponis mollis	1 oz.	(30 cc.)
Adeps lanolina	1 oz.	(30 gm.)

Bedsheets, pillow cases underwear and clothing should be changed. The ointment should then be rubbed into the affected parts daily for four days and the patient should not bathe during that time. On the morning of the fifth day the patient should bathe without applying any salve, then see the doctor to determine whether or not another course of treatment is required or whether there is a dermatitis from the sulphur which sometimes occurs. All under clothes, bedclothes, etc. should be boiled

The following is a recent course of treatment for scabies[4]

Benzyl benzoate	50 gm.
Liniment of soft soap	65 cc.
Alcohol, 90 per cent	30 cc.
Distilled water	5 cc.

A concentrate, to be diluted with 5 parts water when used, having the following formula is of value

DDT	6% by weight
Benzyl benzoate	68%
Ethyl p-aminobenzoate (benzocaine)	12%
Polyoxyalkylene derivative of sorbitan mono-oleate (Tween 80 or the equivalent)	14%

This is applied once by painting all over and then followed after drying, by a second painting which is allowed to stay on.

A pyrethrum ointment has also been reported by S. E. Sweitzer for the treatment of scabies.

Animal Scabies.—Many wild and domestic animals such as fowl and birds are affected by scabies, or parasitic mange. The causative organism is similar to that attacking man and may be transferred to him by contact with diseased animals. As a rule however it does not propagate on the human skin hence, the lesion is transitory and does not show the typical burrows or cuniculi. The incubation period is from a few hours to two or three days, and the disease commonly disappears in three weeks. Animal scabies appears as pin-head-sized papules on the back, trunk, groins, thighs, flexures of the arms, and sometimes the face rather than on those areas commonly involved in the human type

The lower animals most frequently affected by sarcoptic mange are

Horses	Cats	Camels
Donkeys	Chickens	Wolves
Cattle	Canaries	Llama wombats
Pigs	Wood pigeons	Monkeys
Sheep	Sparrows	Foxes
Goats	Lions	Ferrets
Dogs	Tigers	

Scabies Norvegica (Norwegian Itch) is a virulent form of the disease characterized by extensive formation of crusts riddled with galleries which contain innumerable parasites and ova. The lesions may invade the nails, face, and scalp and in certain instances have been known to cover the entire body. This form of scabies occurs among lepers.

In sarcoptic mange contracted by man from horses, dogs, and cats, the pruritus is severe and the papules may have black points due to minute drops of dried blood from scratching. Vesiculation has been reported in a number of cases.

R. Prosser White cites an instance in which a group of veterinary students were infested while dissecting a dead horse whose hide was riddled with *Sarcoptes scabei*. An intensely itchy eruption followed within a few hours and consisted of fiery red elevated papules the size of a large pin-head. Horse mange was extremely prevalent in Central Europe during the World War. Attendants, grooms, hostlers, cavalrymen and horse owners were first affected and from them the disease spread to others not in direct contact with the animals.

Acari from donkeys, goats, sows and mules have been known to attack man but while the irritation is sometimes severe, no acari or caniculi have been found in the lesions. Dairymen's itch due to sarcoptic mange of cattle is rare. *Psoroptes communis* producing sheep scab is seldom transmitted to man.

Mange in the dog may be produced by the *Sarcoptes canis* or by the *Demodex folliculorum* both of which are transmissible to human beings. The red mange due to the *Demodex* is very serious in the dog leading to suppurating erosions, but is not highly contagious. Some cases have, however, been reported in which the organism infested the human skin producing a form of impetigo. The lesions in man from *Sarcoptes canis* usually consist of very fine oval erythematous macules with tiny vesicles at the center. The canine mite is said always to attack the human face thus differing from human scabies in which the face is rarely involved. The disease occurs among dog owners, workers at kennels, servants who attend dogs, and employees of veterinary hospitals and homes for stray animals. Chambers reports the case of a kennelman who cared for two dogs suffering from sarcoptic mange. He developed an itching of the scalp that was almost unbearable at night, and this was followed by alopecia, crusts, and scales.

When scabies is contracted from the cat it characteristically attacks the head first and spreads to the neck and body presenting a papulo-vesicular eruption with abrasions and excoriations. When closely grouped the lesions resemble urticaria. The vesicles soon dry and leave a crust. Itching is severe and increases at night. The organism is *Sarcoptes notoedres minor* the smallest of the itch mites. It lives for only a short time on the human skin.

The swine mite *Sarcoptes suis* Gerlach after infesting man can

be transmitted from person to person and according to Jessionek can be demonstrated microscopically in the epidermal scales from the leg

Scabies from camels has occurred as an epidemic in Palestine among members of the camel corps. The parasite *Sarcoptes equi* is similar to *Acarus scabei* but is somewhat smaller In man the rash appears as follicular papules chiefly on the arms, chest, and legs. Secondary infections may occur from scratching Employees of circuses and zoos are subject to this disease.

Gamasoidosis or Fowl Mite Disease, is caused by *Dermanyssus avium* and *gallinæ*. When communicated to man lesions resembling urticarial papules appear on the hands, forearms, and exposed portions of the neck chest, and shoulders, and may also involve the face and scalp The pigeon mite, *Dermanyssus argas* is similar to *Ixodes* and when it infests man it produces edema vesiculation, urticarial papules, and at times constitutional symptoms. An outbreak of dermatitis in a plant thought to be of occupational origin was proven by one of us to be due to mites coming from the many pigeons nesting over the open windows of the work room

An epidemic of fowl mite disease in a French village was reported in 1830 Most of the inhabitants raised pigeons and used excrement from the coops to fertilize their gardens. Numerous other cases have been reported among French peasants.

Fowl mites are very prevalent on chicken farms in the Southern States and in California. Persons who clean out the coops are attacked by them and they have been known to invade living and sleeping quarters in their vicinity The chicken mite *Lelaps stabularis* frequently lives in the litter of stables and attacks horses, dogs and stablemen. The parasites may occasionally be seen as dark moving specks on the skin. They do not burrow but nest in the sweat and sebaceous ducts, which gape and become inflamed. This is followed by an erythemato-exudative folliculitis. Nodules filled with mites are sometimes formed in the skin

Dermanyssus hirundinis is commonly found on swallows and canaries and about their cages. *Leponyssus sylvarum* occurs frequently on the warbler and in its nest.

Sulsberger and Kaminstein observed 3 persons in one family with dermatoses of several years duration which had been contracted from a canary and its cage. They also reported severe cutaneous lesions in a husband and wife who tended a pet canary with mites.

Animal scabies may be contracted as an occupational disease by farm laborers, hostlers, stablemen, grooms, cavalrymen veterinarians, kennelmen, taxidermists trappers, wild game handlers animal keepers in zoos and circuses poultry farmers, pigeon fanciers, pet shop keepers employees of homes and hospitals for animals, and persons engaged in dressing transporting or marketing birds and poultry or cleaning their cages.

GRAIN ITCH

Pediculoides ventricosus is the causative agent of grain or straw itch. The parasite serves a useful function by feeding on the larvæ of certain insects which destroy grain. When the larvæ become scarce the mites attack man. They do not burrow into the human skin in the manner of *Acarus scabei*, but produce wheals with a central pin-point vesicle. The appearance is characteristic and leads to a prompt diagnosis. The vesicles later become pustular.

A variant form of the eruption occurs as slightly raised erythemato-urticarial spots or papulo-urticarial areas. These may be differentiated from urticaria by the rosy tint, the pinkish white areas characteristic of urticaria being rarely seen. In some cases the central vesicle reaches a diameter of 3 mm. and when occurring on an erythemato-urticarial base may strongly resemble the lesion of smallpox. By excoriation the lesion may acquire the appearance of a traumatic dermatitis.

The trunk is most frequently affected, the appendages being much less involved. A few scattered lesions occasionally appear on the face.

The mites reach the human skin through direct contact with infested grains, most commonly straw, and are rarely carried from one person to another. The disease occurs usually between the months of May and October and affects members of the same household, laborers on the same farm, granary, or factory where infested straw is handled, or workmen transporting the material.

Schamberg and Goldberger in 1909 reported an epidemic of grain itch due to new straw in mattresses which were all traced to one manufacturer who procured his straw from one particular locality. The mites were discovered in the dust and siftings of the straw. Workmen who used it for packing purposes and for making the mattresses, as well as persons who slept on the mattresses, were attacked.

Farmers, chaff cutters, handlers of old hay, millers, bakers, packers, unloaders, and persons working in grain elevators and other places where grain and straw are handled may become infested with the mites.

Barley Itch.—Dock workers unloading certain kinds of barley have developed an itch due to the *Sphærogyna cerealella* which was present in the grain. R. Prosser White cited an epidemic which broke out in a bakery among barley sifters. The eruption consisted of a pruriginous, desquamating, scarlatiniform erythema, with vesicles or wheals beginning in circumscribed patches. On examination the grain revealed a small moth on whose larvæ the mites were feeding.

Glaser describes a baker's itch occurring among workers in granaries, flour mills, and bakeries, especially the small establishments which do not use mechanical processes and have few sanitary arrangements. It involves first the fingers and dorsum of the hands

and may then spread to the forearms, the bend of the elbow the axillæ, face and genitals. There is an acute and chronic type. The former is characterized by a nodular inflammation which is likely to develop into a dry or moist eczema The chronic form develops slowly and presents edematous swellings. The lesions are caused by *Pediculoides ventricosus* and *Tyroglyphus farinæ*.

Pediculoides ventricosus is said also to cause the so-called "water itch" among coolies on tea plantations.

Cotton seed handled in bulk may carry a mite which causes a rash known as "cotton-seed itch" When the seeds are handled in bags the affection does not occur The mite found in cotton seed is related to *Pediculoides ventricosus*

Handlers of raw baled cotton may be infested by *Pediculoides ventricosus* which is sometimes carried on the plants.

Schwartz reported 8 cases of dermatitis in one linseed oil manufacturing plant among workmen who handled linseed oil cake and meal Some of the cases were believed to be caused by mites from the linseed which frequently infested the workmen's clothing crawled over their skin and bit them.

Differential diagnosis must be made between grain itch urticaria chickenpox, and scabies. A history of contact with straw or grain is of great assistance.

Grocer's Itch.—Mites of the family *Tyroglyphus* frequently infest cereals, sugar cheese, and copra (dried kernels of coconut) as well as many other foodstuffs, both animal and vegetable, which have been dried and preserved. These mites are sometimes transmitted to man and the resultant irritation is known as "grocer's itch"

Pastry bakers and workers in sugar refineries or in chocolate and candy factories, and those who can and pack fruits and syrups are subject to dermatitis caused by the sugar mite, as well as by the chemical action of fruit acids and immersion of the hands in hot and cold liquids. The rash usually begins as a simple edematous inflammation which may be complicated by secondary infections.

Dried fruits may be infested by the mite *Carpoglyphus passularum* which attacks workers by direct contact. Cases have been reported in which sorters, peelers, and packers of prunes have suffered cutaneous irritation from this parasite. Women sorting partly damaged dates have also been affected. Dock laborers and workmen engaged in shoveling stacks of figs for a jam factory have developed eruptions caused by the fruit mite. A mite found on dried beans has produced dermatitis in workers handling them.

A mite similar to that of the cotton-seed itch is *Tyroglyphus longior* which infests the dried kernels of the coconut and is found in large numbers in the dust of copra mills. "Copra itch" which frequently affects workmen in these mills, has the same characteristics as cotton-seed itch

Dermatitis is said to occur in the tea plantations of India due to the attack of a mite *Rhizoglyphus parasiticus* (Dalgetty)

Chigger—or chigo itch is caused in the United States by the bite of two species of the family *Trombidiidæ* or harvest mites (Figs. 95 and 96) (1) the North American chigger *Leptus rileyi oudemans*

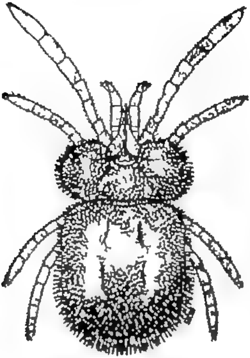

Fig 95.—The North American red bug *Trombicula irritans*, commonly called the chigger (Ewing External Parasites, courtesy of Charles C Thomas)

Fig. 96.—The true chigger —the sand flea, *Tunga penetrans*. (Craig and Faust's Clinical Parasitology)

also called *Trombicula irritans* and (2) a closely related form found in the northern part of the Mississippi valley. The term chigger is also applied to a tropical flea *Tunga penetrans* or *Pulex penetrans*. The chigger or larva of the North American species is oval, bright red, and has three pairs of legs. It is about 150 microns in width. The legs and body are covered with feathered hairs. It has hooked and barbed mandibles by means of which they attach themselves to the skin and feed. The adult is a large, red, hairy mite and is not parasitic. It lays its eggs on the ground and chiggers hatch in the spring. Chiggers occur in the United States from Long Island to Mexico and from the Atlantic to the Pacific. In the Southern States they begin to cause annoyance early in May. The North American chigger is a pest to man, animals, birds and reptiles. They feed upon epidermal tissue which they liquify by a secretion which they inject into the skin. When engorged they drop off. They attack by preference where the skin is thin and wrinkled. They are too large to enter the follicles, and the belief that they burrow in the skin is not well founded. They cause itching and wheal formation or papules about twenty-four hours after exposure. The papules may be surmounted by pin-head-sized vesicles. The itching reaches its maximum in about two or three days and gradually subsides. It may persist several weeks and scratching may cause secondary infection. If there has been an exposure to chiggers, the application of 95 per cent alcohol or kerosene to the skin will kill the larva. A thick lather of soap allowed to remain on the skin for ten minutes before washing off is also useful. The itching may result even though the larvæ are killed. The application of calamine and phenol or strong ammonia may relieve the pruritus. If it is necessary to be exposed, sprinkling of the stockings, shoes, leggings, and underclothing with flowers of sulphur or spraying with a fly repellent such as solutions of pyrethrum or rotenone in petroleum distillate, or applying ointments containing insect repellents will act to ward off attacks by chiggers. Berry pickers, foresters, workers gathering pine oleoresin for making turpentine and rosin, farm laborers, lumbermen, highway and railroad workers are subject to chigger bites.

The sand flea (Chigoe) *Pulex penetrans* is found in tropical climates and infests humans, rats, mice, and other animals. The female burrows into the skin.

Onion Mite Dermatitis.—The *Acarus rhyzoglyphus hyacinthi* swarms over decaying bulbs of various kinds and country people who store bulbs above their beds on shelves or in attics are attacked by the parasites while asleep. Cases of severe dermatitis have been reported in Germany among people occupying a house with decayed onions stored under the roof. Lesions consisting of small round, red itchy papules, excoriations, and crusts have been produced experimentally by the mite. These mites do not penetrate the skin, and it is believed that their excretions are responsible for the irritation.

Rat Mite Dermatitis.—This is usually caused by *Liponyssus bacoti* (Shelmire and Dove) but other species which live on rats may also cause it. They are blood sucking mites and drop off the skin after each meal. They may be seen with the naked eye against a white background. Their bite produces urticarial wheals, papules and vesicles. Sometimes the puncta caused by the bite may be seen. Scratching produces pustules and excoriations which may resemble a traumatic or contact dermatitis. The lesions are usually found on the lower extremities but the uncovered arms and other parts may be affected. The author and others have seen a number of outbreaks of dermatitis thought to be caused by chemical irritants which were proven to be caused by rat mites. The differential diagnostic points are (1) there is usually no industrial skin hazard present (office workers, etc.) (2) lesions are individual and resembling urticaria or bites (3) the whole building or a room nearby directly underneath or overhead of the room where the cases occur is rat infested (4) rat holes or runways can usually be found (5) de-ratting stops the outbreak.

Poultry Mite Dermatitis.—This condition while customarily associated with *Dermanyssus gallinae* and *hirundinis* probably may be caused by a large group of parasitoid mites having great similarity and differentiated with great difficulty except for the skilled entomologist. The bird mite (fowl mite roost mite chicken louse) is about the size of the printed period at the end of this sentence. The mite is about 0.6 mm in length pear-shaped, light gray except after feeding. This parasite passes through three or four molts reaching full maturity in from two to six weeks depending upon environment. It may be brought into industrial plants on garments of workers living on farms, or raising chickens, or by persons caring for canaries.

They may be harbored by rats. Like the true rat mite, these ectoparasites procure a blood feeding and drop from the host. Therefore any epidemic dermatitis caused by mites brought in on workers garments will be short-lived unless day by day such workers introduce new lots. The features of the lesions, the severity and sites are similar to those mentioned under rat mite dermatitis.

TICKS LICE AND FLEAS

Pediculosis.—Lice which infest the human body belong to three varieties: *Pediculus capitis corporis* and *pubis*. The lice which attack the head and body are similar except that the body louse is larger. The pubic louse is the smallest and is of somewhat different shape, resembling a violin.

Head lice, which commonly inhabit the scalp may sometimes be found in the beard among elderly men. The ova cling to the hairs and are easily discovered. Itching may be very severe and excoriations, crusts and sometimes pustules appear. There may be denuded areas which discharge serum pus, and blood. Multiple abscesses

occur after long neglect. The parasites are not confined to people who live in filthy conditions, but may also attack the cleanly.[1]

Body lice usually live in the clothing and attack the skin only in search of nourishment. They are said not to live on silk. The bite produces a papule and excoriations radiate from the primary lesions.[2] Crusts of dried blood over the follicles are characteristic. Neglected cases sometimes develop secondary infections, a frequent occurrence during the World War. Pediculosis is differentiated from scabies by the absence of galleries. DDT powder sprinkled in the clothes or on the skin will destroy body lice.

Pubic lice may occur on any hairy portion of the body, affecting the eyebrows and eyelashes as well as the genital region. They are usually acquired by sexual intercourse and cannot be considered an industrial hazard.

Pediculosis of the head and body is an industrial risk among physicians, nurses, hospital attendants, social workers, school teachers, policemen, soldiers, and sailors.

Ixodes.—The wood-tick, a blood-sucking insect, is abundant in the American woodlands, especially among fir and pine growths. It occasionally attacks man, burying its mandibles with their hooked projections deep in the skin. When the insect, gorged with blood, is pulled away, the mandibles may remain in the skin and cause inflammation at the site of the wound. Foresters, lumbermen, C. C. C. workers and others who work in wooded areas are subject to this risk.

Ticks from cattle, dogs, and other animals may also attack man and produce various cutaneous lesions.

Fowl ticks (*Argas persicus*) produce edematous and indurated papules that develop into pustules. The lesion differs unmistakably from gamasoidosis. *Argas reflexus*, a tick which infests pigeons, may attack man and produce local inflammation.

Rocky Mountain Spotted Fever.—Tick bites are generally conceded to be the means of spreading this disease. Spotted fever is prevalent in Montana among persons associated with herds of sheep in the mountains. Several hundred cases occur in that region annually. Cases have also been reported in the East, particularly in Suffolk County, New York. In the eastern type the dog tick is chiefly responsible.

Between 1920 and 1931, 10 cases occurred in the eastern part of Long Island; there have since been 4 other probable cases. Ticks were common in the neighborhood, and some of the patients gave a history of tick bites. The etiological microorganism is not definitely known, but is supposed to belong to the *Chlamydozoa*.

[1] There are many treatments for killing head lice. Kerosene and olive oil, equal parts, applied to the hair and held in with a cap or dressing for 12 hours, followed by a soap and water wash, is efficacious.

Isobornyl thiocyanoacetate (Thanite) 8 per cent, Decresol O.T. 0.6 per cent, in lotion is said to be more efficacious than kerosene.

[2] Peck found that the itching and papules was caused by sensitivity to the feces of the louse, which defecates as it bites.

The illness is characterized by high temperature and soreness of the body frequently accompanied by headache and epistaxis. The cutaneous eruption appears from three to five days after onset beginning on the wrists ankles and back and spreading gradually over the limbs and body It appears in crops as a purpuric erythema first as a pinkish or reddish macule which turns dark and finally becomes hemorrhagic. In acute affections the hemorrhagic areas may extend over the entire surface of the body

The mortality is much higher in the eastern type of this disease than in those reported from other parts of the United States.

MOTHS AND CATERPILLARS

A dermatitis may result from contact with the hairs of the Brown Tail Moth (*Euproctis*) A chemical poison is secreted in the spike-like nettling hairs of the moth the caterpillar and the cocoon On contact with the skin they cause an irritation marked by intensely itchy erythematous macules or urticarial wheals.

The moth is common in Europe during May and June, and is a menace to vegetation in the New England States and Canada. Gardeners, florists, foresters, horticulturists, and entomologists are exposed to the risk while picking the grubs from trees.

The Gold Tailed Moth (*Liparis chrysorrhea*) may cause cutaneous irritation when the hairs of the larvæ come in contact with the skin Numerous cases of dermatitis have been reported from this cause.

The Goat Moth (*Cossus ligniperda*) secretes in some of its glands more than 30 per cent of formic acid It ejects an irritating greenish sputum with a pungent odor Its larva bores into trees and is known as the auger worm

The Puss Moth (*Cerura vinula*) has a gland which secretes an irritant. The Fox Moth (*Lasiocampa rubri*) and three species of *Chenilles processionnaires* produce a severe irritation on the thin parts of the skin by their barbed hairs, and sometimes by their cocoons. *C processionnaires* live chiefly in pine forests.

FLIES AND WORMS

Myiasis is the term applied to disease produced by the larvæ of flies that hatch on the skin and burrow into it, producing erythema and occasionally cellulitis. In this country the insects which commonly cause myiasis are the screw worm fly (*Chrysomyia macellaria*) which deposits its eggs in open wounds or body cavities and the warble fly (*Hypoderma bovis lineata* and occasionally *diana*) which invades the skin and produces lesions in the subcutaneous tissues.

These flies infest both man and animals, and numerous cases of myiasis are reported among workmen on cattle and sheep ranges.

The tumbler fly or Ver du Cayor (*Cordylobia anthropophaga*) found in Africa is in the same group The young maggot bores into the skin and produces tumors which usually do not break down The larvæ must be removed either by forceps or surgically Lumber

jacks in South American mahogany woods often present an ulcerating dermatitis caused by the larvae of the warble fly

Creeping Eruption (*Larva migrans*) —Creeping eruption is a term applied to an affection of the skin characterized by linear lesions *caused by the burrowing of various larvae. The lines 1 to 3 mm* in width may be straight or wind into loop-like forms. The disturbance is fairly common in our Southern States where Shelmire has shown that it is mostly due to the larvae of cat and dog hook worm (*Ancylostoma braziliense*) Most of the cases are contracted in wet sand when the animals deposit their feces. In the Orient, cases have been reported as caused by cat and pig nematodes. *Cases are also caused by the larvae of the horse fly* (*Gastrophilus equi*) the larvae of *Strongyloides Echinococcus Dermatobia noxialis Lucilia caesar* and *Hypoderma lineata*

Workers in soft damp sand life guards, and others who walk barefoot on the beach may become infested with the parasites.

The infected skin first shows a red itchy papule which in two to three days lengthens into a sinuous tunnel in the epidermis. The *larva moves several mm to 1 to 2 cm. per day the beginning of* the tunnel healing as the burrow advances.

Freezing the skin over the end of the tunnel with a spray of ethyl chloride is said to kill the larva.

Onchocerciasis.—This disease is caused by the Simulium fly or gnat which produces nodules in the skin which contain the adult male and female parasite. After mating in the tumor they give *birth to many microfilariae which circulate in the lymph spaces.* These flies do not bite after sunset and do not breed in altitudes below 2,000 feet. Treatment is by surgical removal of the tumor

Hookworm (Ground Itch *Mazamorra pani ghao*) —Dermatitis as well as constitutional disease is caused by the larvae of *Ankylostoma duodenale* and *Necator americanus* They live in the ground and enter the skin of the feet and toes, where they produce a pruritic papulo-vesicular *eruption* which may undergo ulceration *A brief* contact with mud filled with encysted larvae is sufficient to cause the disease. The full-grown larvae gain entry into the body by piercing the skin and then travel along the sheaths of the hair follicles to the lymphatics. The constitutional symptoms of hookworm disease usually appear a few months later

The eggs and larvae require warmth and moisture for their growth *hence the disease is most prevalent in tropical countries. It has* been recognized in Egypt, Southern Europe, Japan the East Indies Ceylon and South America, and in the Southern United States and Puerto Rico

Agricultural laborers on sugar coffee, banana cocoa, tobacco and rice plantations brick and tile makers, dam builders tunnelers, and miners are most frequently affected by the disease. It is com*paratively rare in Great Britain* but cases have been reported among the tin miners of Cornwall Applications of turpentine and

salicylic acid 3 per cent in ethyl alcohol have proved of value in some cases

Swimmer's Itch (Schistosome dermatitis) is caused by *Schistosoma cercariae* a parasite which lives on snails They are free swimming colorless organisms about 0 7 mm long Man is an abnormal host and the cercariae die in the skin The disease occurs most commonly in the summer but in tropical or semi-tropical climates it may occur throughout the year A few minutes after emerging from infected waters, a tingling sensation is felt on the exposed parts. Pin-point-sized red macules appear and itching follows. The macules enlarge to form discrete papules. Ordinarily the lesions disappear in a week or so but secondary infection may cause pustules which may take longer to heal There is no evidence of systemic infection from this parasite.

The best method of prevention is to treat the water containing the snails with copper sulphate which will kill them Applying a water insoluble protective ointment containing an insecticide which repels or kills the parasite is another method of prevention. Vigorous rubbing with a towel after coming out of the water may rub the parasite out of the epithelium

The swimmer's itch described above must not be confused with the schistosomiasis caused by *Schistosoma hæmatobium* causing bilharziases of the bladder *S mansoni* causing disease of the spleen and intestines *S japonicum* causing hepatic intestinal or circulatory bilharziasis. These parasites are found in Japan and other parts of Asia. They cause lesions similar to swimmer's itch but infection is followed by severe systemic symptoms. Preventive methods similar to those described above are advocated

BITES AND STINGS

The bites of any insect may become secondarily infected and cause severe cutaneous symptoms. In some cases the bite itself produces a dermatitis. Bee stings frequently provoke an extensive and painful eruption among farmers bee-keepers and agricultural workers. The bites of the common house and garden mosquito the black fly the gadfly and warble fly of cattle may cause dermatitis and eczema even when the larvæ do not burrow in the skin

Beetles, leeches, wasps, spiders, ants gnats, and caterpillars may cause urticarial wheals and edema by their bites and stings

Bites of centipedes produce a stinging itch with erythematous edema of the skin followed by fever and other symptoms. Tropical *centipedes are extremely virulent.*

The South Italian tarantula is a venomous spider whose bite causes severe injury to the skin.

In tropical and subtropical countries the mosquito *Culex fatigans* frequently acts as an intermediate host for the parasite *Wuchereria (Filaria) bancrofti* which produces serious disease in man The

more important manifestations are elephantiasis, lymphangitis lymph scrotum, lymph varices, chyluria, and abscesses.

The microfilariae are drawn into the body of the mosquito with the blood sucked from an infected person and make their way into its proboscis. When the mosquito next feeds on a human host the microfilariae burst through the thin membrane of the labium and deposit themselves on the surface of the skin. They readily penetrate into the lymphatic system though not through the puncture made by the mosquito

Disease from this source is common in South America, Southern Asia and Europe, Western and Central Africa, Australia, Arabia, the Dutch East Indies and the West Indies in this country cases have been reported in Charleston Mobile New Orleans, Jacksonville, Tampa, and even Boston.

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CHAPTER XL

DERMATOSES CAUSED BY BACTERIAL INFECTIONS

WHEN one considers that bacterial infections frequently follow industrial injuries to the skin, and may also complicate an occupational dermatitis, their importance as a factor in occupational diseases is readily seen. In some instances, bacterial infection is incurred directly from the materials used in the occupation as in the case of anthrax from infected hides or from living animals. In others contagion may occur from a diseased fellow workman, as in syphilis.

It is necessary in such cases to prove the connection between the lesion and the mechanical trauma which has produced it. If cutaneous tuberculosis, syphilis, or glanders, for example, is contracted at or in consequence of the patient's work and a causal relationship can be proved these diseases become occupational.

Secondary infections which develop following industrial trauma or dermatitis are caused chiefly by the *Staphylococcus pyogenes aureus* and *Bacillus pyocyaneus* In addition to these, there are other bacilli spirilla, and micrococci which act as causative agents, and it is important to understand the relations of these organisms to the various trades, occupations, and industries.

In certain occupations workmen are particularly exposed to the risk of infected wounds. The immediate antiseptic treatment of all cuts will go far to prevent these complications, and is of great value in reducing disability in such industries as the manufacture of barbed wire, in which minor injuries frequently occur

The following diseases involving the skin have been considered occupational when contracted in the course of employment

Noma.—Noma gangrenous abscesses and ulcers of the mouth, in man due to a bacillus of diphtheria in calves.

Oriental Sore.—This affection begins as a papule surrounded by an erythematous halo. The center ulcerates, the border becomes infiltrated, the base becomes fungating and a chronic indolent ulcer forms. The condition is most common in the Orient and in tropical America but may be imported to other countries occasionally Cases have been reported among longshoremen in France The infective agent is *Leishmania tropica* which is carried to man by certain species of insects.

Contagious Pustulous Stomatitis.—This disease manifests itself in the form of pustules pruritus, lymphangitis stomatitis angina and constitutional symptoms. It is supposed to be vaccina transmitted from infected horses.

Septic Vibrio.—Septic vibrio causes septic edema in agricultural laborers who handle manures. (See Agricultural Laborers.)

Trichorrhexis Nodosa.—The cause of this disease is unknown It occurs in cattle and affects their manes and long hairs. Shindelka

and his students developed the condition on the bearded region of the face after contact with a sick horse

This disease was considered to be purely infectious until Sabouraud showed that the hairs of shaving brushes developed the same condition He attributed the brush-like fractures to trauma resulting from washing out of fats from the hairs by the continued use of soap and water Shindelka s report raised the question of multiple etiology with the possibility of both infectious and traumatic causes.

Furuncles Carbuncles, Folliculitis.—These lesions are similar in pathology and differ only in the depth and number of follicles infected Their clinical features are too well known to require description. The etiological agent is *Staphylococcus pyogenes aureus* although other pyogenic cocci may also be found in the lesions. Staphylococci are ubiquitous and abound in great numbers in the dusty and dirty occupations such as street-cleaning and road work, the oil and coal industries, among automobile mechanics and machinists and garage workers. They are most likely to occur among workers exposed to insoluble cutting oils. Predisposing causes are friction filthy and greasy working clothes, infrequent bathing and preexisting itchy cutaneous lesions such as scabies pediculosis and dermatitis venenata.

Treatment.—Treatment with wet dressings of boric acid solution, etc. in conjunction with roentgen-ray therapy gives good results for both furuncles and carbuncles. If the lesions cannot be thus aborted early incision and drainage are necessary Smaller follicular pustules should be opened drained and painted with a solution of gentian violet (5 per cent) or brilliant green (1 per cent) At times, Unguentum Quinolor Compound may be successful in preventing the outbreak of new pustules

Sulfonamides and penicillin therapy used singly or combined have proven efficacious in controlling or in eliminating completely this type of infection. The penicillin may be administered parenterally or locally or both

Daily cleansing shower baths after work and daily changes to clean working clothes will often prevent the occurrence of bacterial infections among workers.

Rose Picker's Dermatoses.—Cutaneous affections due to the pricks of sharp rose thorns are reported among rose pickers in the south of France and the Italian Riviera. The pricks afford entrance to *Staphylococci* and *Streptococci* which produce nodules and tubercles that may break down and ulcerate. Paronychia with associated lymphangitis is another manifestation of this disease. The spines of certain citrus trees may give rise to similar infections.

Impetigo Contagiosa.—This affection must be considered as a possible secondary infection in industrial dermatoses. It is however difficult to prove a causal relation since the disease is highly contagious and the streptococcus which is the etiological agent may be

encountered anywhere, as is well illustrated by the prevalence of impetigo among children.

The primary lesion is a superficial vesicle or bulla containing serum which quickly changes to pus. The wall is thin and ruptures early and the drying of the purulent discharge forms superficial yellowish crusts.

Ecthyma.—Ecthyma a pustular infection similar to impetigo but more deeply seated was a frequent complication of scabies and pediculosis among soldiers during the World War It is sometimes seen complicating or associated with infections in industrial dermatoses. It is a pustulo-ulcerative pyoderma. It is auto-inoculable beginning as a pustule containing a creamy pus which dries and forms a brownish rupial crust. Lesions are usually multiple and after healing leave a pigmented scar thus differing from impetigo contagiosa, which leaves no scar It is also caused by the *Streptococcus* Two cases of infection with ecthyma contagiosum a virus disorder of sheep were reported by Dr Ruben Nomland. It may occur in persons who handle the infectious material either the animals or the vaccine.

Dermatitis Contagiosa Pustulosa Canadensis, or "horse pox is another streptococcus infection. It is transferred to human beings by contact with diseased horses, and manifests itself on the skin in the form of bullæ pustules, and scabs closely resembling impetigo contagiosa. It is highly contagious and stablemen are frequent victims of the disease. Treatment is the same as for impetigo

A streptococcus infection of the skin among women who wash sausage skins is reported by Adamson. It is characterized by bullæ which rapidly break down and leave ulcers of an ecthymatous type Adamson regards this as an ulcerative form of impetigo

Erysipelas.—Any break in the continuity of the skin from major wounds, ulcers, eczema, and other cutaneous disease to slight scratches and unnoticed abrasions, can provide an entry for the streptococcus, which causes erysipelas. The eruption is a localized inflammation which spreads at the periphery the skin becomes infiltrated red and glazed and vesicles and bullæ develop in the area. The border of the lesion is well defined and does not show peripheral islands. There are constitutional symptoms high temperature, malaise and headache. Some cases prove fatal through complications.

The disease may develop among employees in any industry where skin wounds occur

Treatment.—All previous methods such as anti-streptococcic serum, the quartz lamp and local applications of ichthyol, silver nitrate collodion, and ethyl chloride spray have been discarded in favor of the sulfonamides.

Erysipeloid.—Erysipeloid (Rosenbach) is caused by a microorganism *Bacillus erysipelatos suis* The several strains vary in virulence, and produce different clinical pictures. (Fig 97.)

The common form manifests itself as a small red spot on the hands

or fingers, which spreads slowly to adjacent parts and clears in the center. The color is characteristically violaceous or purplish-red. The infection is usually accompanied by itching and burning sensations. Only in the more severe forms with an associated lymphangitis are constitutional symptoms present and these consist of low fever, mild headache and malaise. The condition clears up spontaneously within four to six weeks.

FIG. 97.—Erysipeloid (occupational) among meat handlers. (Case of Dr. J. V. Klauder.)

The organism of erysipeloid appears to be widely distributed in Nature. It is resistant to dryness, light and long exposure to the air and grows readily on dead animal materials. The disease attacks persons handling fish, meat, poultry or the hides, pelts, bones, and manure of infected animals. Fishermen, cooks, butchers, and meat inspectors are particularly subject to this risk. Cases have been reported in which the infection was conveyed by kid shoes and clothing. Veterinarians have been infected by the prick of a needle containing the serum of diseased animals and laboratory workers while making postmortem examination of birds. Gilchrist has reported over 300 cases in which the disease followed a bite or other injury from crabs. The slime of fish is believed to carry the infection although the organism has not been found in it. Among fishermen the disease is a frequent cause of disability. Cases of erysipeloid have been described by German authors among lard makers and have been ascribed to infection by contaminated raw products.

Treatment.—Treatment consists in the use of wet dressings of potassium permanganate 1 to 5,000, chloride of lime or bicarbonate. The milder infections clear up spontaneously in a few weeks.

Miscellaneous Dermatoses of Marine Workers.—There are a number of ill-defined dermatoses which affect various marine workers such as sailors, fishermen, longshoremen, etc. Many are due to trauma and secondary infection or prolonged contact with brine. "Haddock rash" affects the smokers of this fish who partly dissect the fish and place them in brine. The name "haddock rash" is applied to various skin eruptions and infections of different etiology.

Butcher's Pemphigus.—This is a rare disease, also known as Acute Infectious Bullous Dermatitis, which occurs chiefly among

butchers and other persons who handle dead animals.* It generally follows a septic wound of the hand. While the causative organism is not definitely known, it appears that the disease is of bacterial origin. A special diplococcus similar to that described by Demme has been isolated in certain cases, and is believed to be the infective agent.

The disease is characterized by bullæ which arise from the clear skin twenty-four to forty-eight hours after inoculation. In some cases there is a generalized eruption of erythematous papules, vesicles, and bullæ, with a pink areola around the border of each lesion. All layers of the skin are involved in the inflammatory process, and there is an accompanying high fever. The mouth, palate, and nostrils are almost always affected, and extreme fetor is a common symptom.

In fatal cases the bullæ coalesce, their contents become purulent and hemorrhagic, and the outer layers of the epidermis come off in large sheets.

Treatment consists in the administration of quinine in large doses, vaccine if an organism can be isolated, and soothing lotions locally.

The prognosis is grave, death resulting from toxemia within a few days in the great majority of cases.

Prophylaxis should be carefully observed by prompt attention to wounds received by butchers, meat handlers, and others in contact with dead animals.

Brucella Eruption.—This occurs in veterinary surgeons and stock men who come in contact with *Brucella abortus* in the secretions of affected cows and pigs, and sometimes in workmen who handle beef and pork in slaughter houses. Infections have also been reported among laboratory workers in contact with these bacteria.

The eruption simulates a contact dermatitis. It appears a few hours after inoculation in the form of pin-point to lentil-sized papules with tiny central vesicles which later become pustular. The itching is moderately severe. In healing, the lesions leave pigmented scars. The disease normally lasts about three weeks, but recurs upon contact with infected material. Since the pustules are sterile, limitation of the eruption to the forearms and a history of contact with infected animals assist in the diagnosis.

Treatment.—Treatment is by application of wet dressings or soothing lotions. Since the lesions heal spontaneously in so short a time, prophylaxis is more important than treatment. The skin should be covered with some fatty material, or rubber gloves worn when operating on or otherwise handling infected animals, and the hands and arms should be thoroughly cleansed afterwards.

The most recent addition to therapy, which acts almost as a specific, is the use of penicillin and the sulfonamides.

Pig-breeder's Disease (Eruptive Meningotyphus) occurs in France, Switzerland and Italy among workers in contact with diseased pigs which are fed with waste from cheese-making. The

* Acute pemphigus also follows vaccination in occasional cases.

etiology is undetermined, but the organism is believed to be a filter passing virus During the third or fourth day an extensive eruption sometimes occurs but disappears without subsequent desquamation of the skin.

Elephantiasis.—*Elephantiasis nostras* or lymphedema, is believed by many observers to be caused by infection with *Streptococcus pyogenes* The tumefaction frequently follows repeated attacks of erysipelas, erysipeloid fungous infection, and pyogenic infections associated with repeated lymphangitis and cellulitis of the skin adjacent to the focus of infection. The process is brought about by inflammation congestion, venous and lymphatic stasis, and finally hypertrophy The course of the disease is intermittent, each attack leaving the affected skin more swollen and hypertrophied

When secondary to repeated infections incurred in an occupation elephantiasis may be regarded as an industrial disease.

Treatment.—Treatment is removal of the cause elevation of the limb antiseptic dressings, and elastic bandaging Fibrolysin has been used with some success by Castellani and Elliot recommends antistreptococcic serum in addition to local treatment. Successful therapy has been met with in the use of the sulphonamides and penicillin

Tularemia (Deer Fly Fever).—The disease is caused by inoculation with *Bacillus tularense* which is transmitted by contact with certain animals especially rodents, or by the bites of wood ticks, deer flies, and other blood-sucking insects which have attacked infected animals. Contact of the hands or conjunctivae with the internal organs or body fluids of such animals, particularly rabbits, is a frequent means of infection Many cases occur during the rabbit-hunting season in persons who dress the animals. Cases have been reported from the bite of a coyote, a gopher and a ground squirrel Muskrats, opossums, woodchucks, European water-rats, sheep quail sage hens, and pheasants have also conveyed the infection to man The disease has been reported from 30 States in America and from Japan and Russia its greatest incidence occurring in seasons when ticks and flies are numerous.

Persons working in fields and forests, who are exposed to ticks and deer flies handlers of rabbits and other wild game *e g* market men and cooks, are subject to infection with *Bacillus tularense* Physicians and laboratory workers may be infected by experimental animals

The disease is both cutaneous and systemic and occurs in two forms. The ulcero-glandular type begins as a nodule usually on the finger which later ulcerates and sets up a lymphangitis. The glands swell and form subcutaneous, broken-down nodules resembling those of sporotrichosis. The eruption may be accompanied by headache nausea joint pains, and elevation of temperature to from 102° to 104 F

The second or typhoid type is usually entirely systemic although a toxic erythema may occur in some cases.

The ulcero-glandular type must be differentiated from sporotrichosis, septic infection glanders actinomycosis, anthrax and primary syphilis, and the typhoid type from typhoid and other fevers and from acute miliary tuberculosis. The agglutination test is the only positive way to make the diagnosis of tularemia.

Treatment —No satisfactory specific treatment is known but antiseptic dressings, antipyretics, surgical incision and drainage of the suppurating lymph glands *after* they have broken down neosalvarsan intravenously and oral and intravenous administration of quinine have been used with good results. Specific tularemia antiserum given at an early stage shortens the course of the disease.

Although recovery is slow the prognosis is favorable fatal cases usually are the result of complications.

Glanders (Equinia or Farcy) —Primarily a disease of the horse ass, or mule, glanders may be conveyed to man by the nasal and other secretions of affected animals. It is caused by *Bacillus mallei*, which enters the human system through a break in the skin or mucous membrane and produces symptoms after an incubation period of a few days to a week. The constitutional effects are fever malaise, headache, and pain in the joints and muscles.

When the bacillus enters by way of the skin a red painful swelling occurs at the site of entry and breaks down to form a rapidly spreading ulcer The adjacent glands become swollen and tender and frequently develop abscesses. As the disease progresses, similar lesions appear on other parts of the skin Large areas of infiltration discharging purulent material from numerous openings frequently occur Characteristic nodules or farcy buds form along the lymphatics at a distance from the site of inoculation and tend to break down into discharging ulcers. In acute cases there is a characteristic bloody and offensive nasal discharge. High fever rigors, vomiting diarrhea and feeble, rapid pulse lead to delirium coma, and death

Treatment.—Treatment is symptomatic and surgical Although the prognosis is grave, most cases terminating fatally within ten days, an occasional mild case may recover

The chronic type is much less frequent. It may persist for months or years, with eventual recovery or may fulminate at any time with fatal results.

For the past thirty years the disease has been extremely rare and is now practically extinct in Great Britain where farmers grooms, teamsters, and blacksmiths were frequent victims three decades ago. Two acute cases were reported in New York City and 3 in Milwaukee in 1907 1 fatal case occurred in 1908, in a Chicago physician who became infected from a laboratory culture.

Anthrax (Malignant Pustule) —*Bacillus anthracis* is conveyed to man from diseased horses camels, sheep goats, and pigs. In Great Britain Australia New Zealand and the United States, the disease is comparatively rare but in countries where precautions are not taken to prevent it, as in Russia Siberia, Turkey Asia Minor Persia, Mesopotamia India Tibet China, Japan, the Straits Settle-

ments, Egypt, South Africa, and Peru it is common and a quantity of infected material is exported from these countries.

If an animal dead of anthrax is immediately buried without opening the carcass or removing the skin there is no risk of infection to man or other animals the bacillus dies in about a week. Once the blood from such an animal comes in contact with the air however the bacilli form resistant spores. They are able to remain alive for years, and fleece, wool skin, or other part of the carcass upon which the blood has dropped contains them Such material when dried gives off dust filled with the spores. This dust readily falls into cuts or even minute scratches on the skin or is inhaled into the lungs. Thus anthrax may occur in those who handle living animals suffering from the disease infected carcasses or any parts of such carcasses either at the time of death or subsequently Such materials are wool horsehair hides, and horn Anthrax has even been contracted by longshoremen through unloading contaminated grain and by persons using infected shaving brushes.

Sporadic cases of anthrax and a single small epidemic were reported by Macdonald in 1930 as occurring in a carpet mill Thirty one of 48 cultures of raw wool taken from 9 different lots of material used in the factory shortly after the infections occurred showed *Bacillus anthracis* Dust from the floors and dusting machines, however did not harbor the organisms The author describes a procedure for destroying the organisms, in which prompt attention to minor cuts and abrasions and proper cleansing of the skin of workers is stressed Excellent clinical results in treatment were secured by intravenous administration of anti-anthrax serum excision of the infected area is contraindicated

A death from anthrax occurred from skinning minks.

The workers most exposed to anthrax by reason of their occupations are

Butchers	Upholsterers	Hair curlers, sorters and dressers
Dairy workers	Shoemakers	Brushmakers
Longshoremen	Warehousemen	Mattress makers
Wool sorters	Slaughtermen	Furriers
Carpet makers	Herders	
Cloth makers	Ranchmen	
Blanket makers	Tanners	

Imported materials made into leather articles hair cloths, carpets, cloths, blankets rugs, pelts, and brushes should be disinfected before they are used

The disease may occasionally be transmitted from one person to another *e g* to physicians at autopsies, to nurses and hospital attendants through lack of precautions and to laundry workers who wash infected clothing

Eighty-four per cent of the cases reported from London Hospital were of occupational origin.

The disease may be constitutional but the cutaneous form is by far the most common. Inoculation usually takes place on some

exposed part of the body through contact with infected dust, most often the head, face or neck, less often the limbs and trunk. (Fig. 98.) The lesion is a carbuncle-like papule with a necrotic black center surrounded by vesicles and inflammatory swelling. The temperature rises, and regional lymph nodes become enlarged and tender and often suppurate; metastatic abscesses may develop. In the more severe cases the edema and necrosis increase, and death may result from septicemia. The average mortality is about 11 per cent. In most cases recovery takes place by separation of the scab and recession of the lesion.

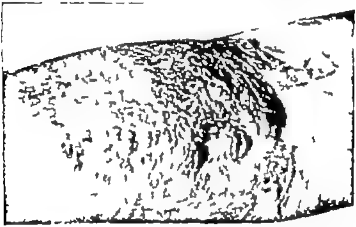

Fig. 98.—Cutaneous anthrax. Worker with imported goat hides. Recovery after treatment with anti-anthrax serum. (Case of Dr. Herman Gold.)

Wool sorters' disease, originating from inhalation of the dust from wool, is pulmonary without external lesions, and is always rapidly fatal.

Treatment.—Treatment for the cutaneous type consists of rest in bed and strapping of the affected part, combined with intravenous injection of Sclavo's anti-anthrax serum (80 cc. or more on the first day, and 60 cc. on the second if there has been no reaction). Subcutaneous injection is less effective. Excision of the lesions has been employed although Hunter believes this to be unnecessary, only delaying cure and adding to the risk of generalizing the infection. Lucchesi and Pascal reported 48 cases treated without a fatality. They favor neoarsphenamine, reserving serum for those patients with the internal type with a blood stream invasion, or with lesions on the face or neck. They emphasize that hands must be kept off the local lesion. Since the disease is capable of spontaneous cure, it is difficult to evaluate any method of treatment. Throughout South Africa novarsenobenzol is said to be used without surgical intervention. Legge's figures published in 1934 for the treatment of 800 cases show that the mortality could be reduced

from 11 per cent to 4 per cent by the use of Sclavo's serum. All treatment fails in pulmonary anthrax. Since the introduction of penicillin and the sulfonamides, reports show that the "bacillus anthracis" is sensitive to both drugs.

Prophylaxis Against Anthrax.—Erich mentions East Indian goat hair, cashmere, mohair, and Egyptian, Persian and East Indian wool as the articles most frequently reported as causing anthrax.

Hunter lists the protective measures required by the British Government and practiced at the Port of Liverpool. The process applied to wool and horsehair, known as "Duckering," follows:

1. Removal, without human contact, of the bale or other covering by machinery which is completely enclosed and equipped with a dust extracting apparatus.

2. Preliminary treatment to bring the spores into a condition to be easily killed. This consists of agitation by means of rakes which thrust the wool through liquid, first for ten minutes in an 0.5 per cent solution of sodium carbonate, and second for ten minutes in an 0.5 per cent soap solution containing a little free alkali, both solutions being at a temperature of 102° to 110° F., and finally by squeezing through rollers.

3. Disinfection by agitating the material for twenty minutes in a 2 per cent solution of formaldehyde in water at 102° to 105° F. and squeezing through rollers.

4. Rinsing in clean water at a temperature of 102° to 105° F. to remove excess formaldehyde solution, squeezing through rollers, and drying in a current of air heated to 160° F.

The problem of disinfecting hides and skins without damaging them has not yet been satisfactorily solved.

Removal of dust in factories and workshops by downward exhaust ventilation and the wearing of rubber gloves are additional measures of protection.

Tuberculosis Cutis.—Cutaneous tuberculosis is relatively uncommon. It occurs chiefly in children, but adults may occasionally contract the disease by direct inoculation through a break in the skin whether or not there is an existing tuberculous process in other parts of the body. If the entry is provided for the bacillus by an industrial wound, the disease may be regarded as occupational.

A number of forms are recognized. Those most likely to occur in adults by direct inoculation of the skin are *Tuberculosis verrucosa cutis* and *Verruca necrogenica*.

Tuberculosis Verrucosa Cutis is seen most frequently on the dorsum of the hands, from which it may spread to the forearms, but very rarely to the palms. The feet and legs may also be affected. The lesions appear as coin- to palm-sized plaques. They are irregular in outline, movable, brownish-red in color, and definitely circumscribed. The lesions closely resemble those of blastomycosis, from which they can be differentiated by the absence of fungi. The plaques are often covered with fine pointed vegetations, small

pustules, and crusts. They heal spontaneously in spots, leaving atrophic scars, and spread at the periphery

Variant types may show exuberant soft, red excrescences elevated 1 to 2 cm. above the skin surface, divided by deep fissures suffused with mucopus, and often covered with dark crusts. Or a growth may occur which is both papillomatous and sclerotic, interspersed with verrucous lesions, vegetations, and shallow ulcers.

Cases of the first type have occurred in tuberculous miners from wiping their mouths with the back of the hand One case was reported in a butcher-shop employee who became infected through a wound from electric wiring, and 2 cases in persons working with diseased cattle. A case of bovine tuberculosis of the index finger in a milker was reported This was considered an occupational disease since bacilli had been found in the stable and had been contacted by the milker in the course of his work.

Treatment.—The treatment for tuberculosis in general also applies to tuberculosis of the skin. There is no specific internal medication Local treatment consists of destruction of the growth by endothermy cautery radium or roentgen irradiation

Verruca Necrogenica (Anatomical Tubercle or Postmortem Tubercle).—This lesion occurs through accidental inoculation with the tubercle bacillus at the site of a wound or abrasion It is most often incurred by persons handling or dissecting cadavers and the lesion is usually situated on the thumb or index finger It starts as an inflammatory violaceous papule or nodule with a deep-seated base, slowly increases in size and develops pustules at the center and has an elevated infiltrated border There is usually only a single warty lesion which may persist for months or years but occasionally multiple lesions occur

Physicians, anatomists, attendants in dissecting and autopsy rooms, hospital attendants and nurses, as well as butchers, slaughter house workers, and handlers of cattle are subject to this malady

The treatment is the same as for *tuberculosis verrucosa cutis*

Avian Tuberculosis.—The avian tubercle bacillus which affects fowls and birds is known also to infect some mammals for example swine and cattle. A few cases of this infection have been reported in man, although the incidence is extremely low

Avian tuberculosis in man most frequently affects the skin the lymph glands, kidneys, spleen and bone marrow The cutaneous manifestations consist of ulcers abscesses, tumors, or sarcoids.

Positive diagnosis of this infection is difficult and requires long and skillful laboratory procedures involving cultures and animal experimentation. In suspected cases, the intradermal tuberculin test should be made using both avian and human types. The reaction to the avian tuberculin should be more strongly positive than to the human. Avian tuberculin therapy is likely to arrest or improve the condition but in our present state of imperfect knowledge the prognosis is unfavorable

Syphilis.—The cutaneous manifestations of syphilis are too well known to need recapitulation here. Our only concern is with the disease as an industrial hazard. Fortunately the malady is now so well understood and controlled as to make it an infrequent cause of disability through occupational contagion. However greater protection of workers is still to be desired and for this industry must be held responsible.

A syphilitic employee in the secondary stage with mucous patches in the mouth swarming with spirochetes, or with secondary rash on the skin can easily infect other workers. All the moist and discharging lesions of the skin both in acquired and inherited syphilis are a source of danger. The infection can be spread by drinking cups or other utensils used in common.

Physicians may acquire the disease in the course of medical examination or while vaccinating infected individuals. Tattoo needles wet with the saliva or mucus of a syphilitic patient may transmit the infection. Musicians who play wind instruments may acquire the disease from the mouthpiece of an instrument previously used by a syphilitic person. Nurses, laboratory workers, dentists and their aides, hospital employees and bath masseurs are exposed to the risk.* Glass blowers have contracted syphilis from using a blowpipe in common although in factories where machinery has superseded hand labor this hazard has been abolished.

The worker suffering from syphilis is a danger to himself and his associates in other ways also. The disease plays havoc with all the tissues and organs of the body affecting chiefly the central nervous system, the vascular system, the heart, liver, eyes, and ears. The resulting incapacities such as defective sight and hearing, interference with gait, defective memory and general unreliability due to involvement of the central nervous system render the victim of syphilis especially prone to accidents and a menace to the safety of his fellow workmen.

During the latent period syphilis may be a complicating factor in other diseases or physical injuries, since the sufferer is prone to attribute the prolonged convalescence and partial disability to the injury itself rather than to the underlying disease. Scheuer discusses this in his article on occupationally infected syphilitics. He states that, in the tertiary or latent stage, injury to the skin may produce lesions which become indolent and are cured only by antiluetic therapy.

We observed a case in a truck driver who developed an eruption on the left forearm on three different occasions over a period of two years. A diagnosis of tertiary syphilis was made on the basis of crescentic formation, broken-down nodules along the border, absence of active recurrence in the old scar, the unilateral distribution and

*One of us saw a doctor with an initial lesion on a finger following a nose operation on a syphilitic. A similar lesion was seen on the finger of a dentist after treatment of a patient with mucous patches in the mouth.

a positive Wassermann reaction The patient associated each recurrence of the eruption with a blow received in his work.

Scheuer also reported a series of cases among paper-hangers, cabinet-makers, shoemakers, saddlers, painters, and dressmakers who were infected by putting to their lips or into their mouths things like pencils, nails, awls, needles, wire, thread and brushes previously used by a syphilitic worker also clerks, accountants and waiters, infected by lead pencils, penholders and even coins also persons in the laundry and rag industries.

It is a generally accepted fact that syphilis can simulate any constitutional or skin disease. Therefore, it is necessary to have a working clinical knowledge of syphilitic eruptions, eruptions due to constitutional causes, and those due to contact. Equipped with this information one can readily differentiate among the various skin manifestations.

A positive dark field and positive Wassermann will of course, give us an immediate specific diagnosis as opposed to an occupational dermatitis, in which both these tests would be negative A history of receiving arsenical therapy for syphilis will rule out any occupational cause.

Cases of alopecia, of the moth-eaten type, especially at the hair line speaks definitely in favor of syphilis in its acute stage in contradistinction to alopecia areata of occupational origin.

The color of the lesions in a pustular eruption in syphilis differs from those in chloracne In the first place it is a dull red color while in choracne it is bright red In a pustular syphiloderm there are not the comedones usually found in chloracne. In chloracne milia and cysts are also present and not in syphilis.

A history of exposure to fumes of chlornaphthalene chlorinated hydrocarbons in cutting oils, chlorphenols, chlorbenzols and chlordiphenyls, is necessary to substantiate a diagnosis of chloracne Again the positive or negative result of blood serology in conjunction with all the above factors, must be considered important in the differential diagnosis

Since vesicles are uncommon in syphilis, and present in the great majority of contact dermatoses, this should be a very important differential diagnostic point, especially in the latter where there is a diffuse erythematous base

Treatment.—Persistent therapy of syphilis is so adequate especially with the recent introduction of penicillin that the major emphasis in industry should be placed on prevention of contagion. Wassermann tests should be made on all prospective employees and periodically on those already employed. The early syphilitic worker should be isolated until proper treatment has rendered him non-infectious. The custom of using individual drinking cups has done much to reduce the risk of infection. Further education, especially on the dangers of common use of instruments and tools that touch the mouth should help to eliminate syphilis as an industrial hazard To control syphilis in industry routine blood tests

should be done on all new employees, the results of course to be kept confidential. Those in the non-infectious stage may be allowed to work with a proviso that treatment of the disease should be checked by the factory doctor.

Spirochætosis.—In this group of diseases due to pathogenic spirochætes are included yellow fever, recurrent typhus, trench fever and infective jaundice. Since the latter appears to be increasingly an occupational disease we will briefly describe it here.

Spirochætosis Icterohæmorrhagica (*Weil's Disease*) is an infectious disease with a symptom-complex of fever, enlargement of the liver and spleen, icterus, and cutaneous hemorrhages. The infecting organism is *Leptospira icterohæmorrhagiæ* which is present in the kidneys of rats. Field fever, reported from Germany, appears to simulate Weil's disease, but without jaundice.

Rat Bite Fever.—This disease has been reported chiefly in Japan, England, France, and America. Inoculation may occur from the bite of a rat, ferret, mole, cat, or dog. Cases have also been reported from the bite of a pig and of a wild mouse. Ulceration of the wound sometimes occurs and there may be an accompanying adenitis and lymphangitis. Constitutional and cutaneous symptoms usually appear in from twelve to thirty days. The former consist of chills, and general malaise. Cutaneous manifestations are large purplish macules with a pale center, scattered over the face, neck, and feet, while the rest of the body may have a mottled appearance. The scalp is sometimes the site of partially bald patches.

The disease runs an irregular course, and if left untreated, may last for months with exacerbations and remissions.

The infective agent is not definitely known. Various organisms have been isolated, among them *Spirochæta morsusmuris*, a *Sporozoön*, a *Diplococcus*, a *Streptothrix*, and a *Streptothrix*-like body.

The disease clears up readily on the injection of arsphenamine every five days. Prompt cauterisation of the bite with carbolic or nitric acid is said to prevent development of the infection.

Persons working in rat-infested surroundings, such as farm laborers, ditch diggers, and canal and sewer cleaners who are subject to the bites of these rodents may incur rat-bite fever as an occupational disease.

Necrobacillosis.—This is a disease occurring in animals from infection with *Bacillus necrophorus* (*Actinomyces necrophorus*). It causes diphtheria in cattle, gangrenous dermatitis in horses and mules, and necrotic foci in the livers of cattle and hogs. It may infect man through contact with diseased animals or their meat. Stamen and Shaw reported a case occurring in a government meat inspector, who became infected through a scratch on the hand in the course of his work. The disease manifested itself as intense edema of the hand and arm, fever, and prostration. *Bacillus necrophorus* of Dammann was found in the bullous content of the lesion. Incision and wet dressings cured the condition.

Verruga Peruana (Carrion's Disease).—Little was known about this disease up to 1870 when a disastrous epidemic occurred which resulted in 7,000 deaths among laborers on railroad construction work in Peru. Through the researches of Noguchi the disease was proved to be identical with Oroya fever caused by *Bartonella bacilliformis* (Strong) and transmitted by the midge *Phlebotomus noguchii*.

According to Howard Fox, the disease occurs chiefly in Peru on the western slope of the Andes, and only at an altitude of from 2,800 to 9,000 feet. The midges attack only between sunset and sunrise. The incubation period is from fifteen to forty days. The malignant type (Oroya fever) begins with symptoms of fever, intense pain in the muscles and joints, petechiae and delirium. Its most characteristic feature is an extreme and rapid anemia. The mortality is from 10 to 40 per cent.

The benign type is said to be like no other known disease. It manifests itself on the skin either as pin-head to split-pea-sized pinkish or bright red papules frequently arising on a tiny petechial spot, or as a vesicle or pustule. The lesions are usually distributed symmetrically. Subjectively, there is at first a prickling sensation which is followed by considerable itching. A nodular type has been described which appears as small hard, round subcutaneous bodies, usually on the extensor surfaces of the extremities. The so-called mula lesion is merely a large nodule that has broken through the skin and become secondarily infected.

No specific therapy is known. Prognosis for the eruptive type which may last from four to six months, is favorable.

Milker's Warts.—There is a bullous-verrucous affection on the teats of cows which is usually called "pox" and which may become epidemic among the animals, especially in warm weather. It may be transmitted to man and cause minor epidemics.

In the human form, characteristic granulomatous lesions appear at the site of inoculation on the hands, the so-called milker's warts. The disease may be complicated by a more or less extensive secondary exanthema consisting of pea-sized, indolent, reddish-blue nodules on the fingers and forearms. In some cases there are papules, vesicles, purulent bullae and crusts. The disease is found among sheep, cows and other animals and may be transmitted to milkers, animal tenders, and slaughterhouse workers. The lesions disappear without treatment within a few weeks and leave no mark.

The infective agent is believed to be a filter passing virus closely related to that of variola vaccinia, *Strongyloplasma paravaccinia* (Lipschütz) which is known to produce "vaccine rouge" or paravaccinia (v. Pirquet). Nodules on the hands of goat milkers in Italy has been reported by Prieto, *et al.*

These "milker's-nodules" are probably similar to those reported in 1940 by F. T. Becker. He postulates three theories as to etiology: (1) that the virus is identical with that of vaccinia, (2) that the

virus is attenuated vaccinia (3) that it is distinct from vaccinia (paravaccinia of Lipschütz)

Bonnevie reported 4 cases among male and female laborers who milked cows. He treated them with dry sterile bandages, 1 per cent resorcin and 0.1 per cent silver nitrate, or pure zinc paste. Two cases were irradiated with the Finsen light.

The risk to dairy workers is slight under modern methods of machine milking and rigid inspection of cows.

Vaccinia.—Vaccinia is a dermatosis caused by the organism of cowpox. The lesion starts as a papule, becomes vesicular and finally pustular with a wide swollen erythematous halo, and frequently ulcerates. The hands and fingers are affected. A bullous eruption called white- or blister-pox is also thought to be due to the same organism. The disease in cows affects the teats and udders without injuring the general health. Milkers and others who come in close contact with the infected parts of the cow contract the disease.

Pyogenic Granuloma (Botryomycosis).—Horses, cattle, swine and human beings may be affected with pyogenic granuloma which consists of small pedunculated granulomas, frequently if not always arising in an infected wound. Castrated animals are prone to develop the lesion at the site of operation, and veterinary surgeons may receive the infection at the same time.

The etiology is not certainly proved, but the *Botryomyces equi* (*Micrococcus ascoformans*) is believed by many authorities to be responsible. Others consider the *Staphylococcus aureus* alone as the causative agent. These organisms have both been found in the lesions and also *Bacillus coli*, *Bacillus proteus* and *amebae*. It is possible that none of these is the true etiologic agent.

After a long period of incubation, a hard nodule appears at the site of inoculation. It is bright red, purplish, or brownish-red in color and presents areas of ulceration and necrosis with a purulent secretion. The growths usually appear in man on the hand, foot, face, shoulder, back, or umbilical region.

The usual treatment is excision or destruction either by endothermy or cauterization. Ormsby has had excellent results from roentgen-ray irradiation. The prognosis is good, but there is a possibility of recurrence.

Contagious Pustular Dermatitis ("Orf") has been reported in humans. It begins as a painless hard red papule which enlarges and becomes umbilicated to resemble a huge red tumor of molluscum contagiosum. The depressed center contains clear serum which later becomes purulent and granulations heap up resembling pyogenic granuloma. The lesions respond to antiseptic dressings.

CHAPTER XLI

OCCUPATIONAL DERMATOSES FROM MYCOTIC INFECTIONS

In making a decision concerning the occupational origin of fungous diseases, certain questions arise: (1) whether the infection was incurred outside of working hours; (2) whether conditions existed in the industry which could have caused infection of the unbroken skin; and (3) whether injury or trauma incurred in the occupation had laid the skin open to fungous infection.

Ringworm, particularly of the foot, frequently occurs among patrons of amusement places, such as athletic fields, gymnasia and public baths, and can be attributed to occupation only when it attacks employees of such places.

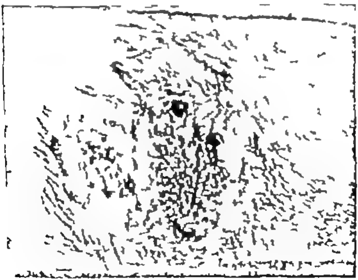

Fig. 99.—Sporotrichosis on the wrist of a nurseryman from a barberry thorn. (Case of Drs. Foerster and [illegible].)

Some organisms, such as *Actinomyces* and *Sporotrichum*, when affecting the skin directly, usually enter through an open sore or wound. A South African miner developed sporotrichosis in a cut on the hand received while at work. In the State of Georgia a man scalded in the course of his work developed blastomycosis in the lesion, and was awarded compensation. (Figs. 99 and 100.)

Another problem, perhaps the most baffling that confronts the industrial physician, is raised by the dermatophytids that occur in connection with dermatophytosis, or ringworm infection. Distant eruptions are frequently seen in virulent fungous infections, often of animal origin, but also the result of superficial human ringworm, especially following irritating local treatment. Dermatophytids may be produced in susceptible cases by the intracutaneous injection of trichophytin.

FIG. 100.—Sporotrichosis in a Brazilian farmer. (Dr. Rabello's Clinic, Rio Janeiro.)

A dermatophytid from foot ringworm frequently manifests itself as an eczema of the hands, especially in the form of dyshidrotic eczema or pompholyx. The eczema may have the appearance of a contact dermatitis of occupational origin, although the fungous infection from which it is derived has in all likelihood been contracted away from work. The physician must differentiate between a contact dermatitis and a dermatophytid. Such differentiation presents considerable difficulty. The trichophytin test may be

positive, but its diagnostic value is doubtful. It is group specific only and merely implies the presence of a little understood form of immunity which is almost as widespread as the causative dermatophytons. It is evident that criteria other than a positive trichophytin test and the presence of a focus of fungous infection in the toe-webs are needed in order to diagnose a dermatitis on a worker as a dermatophytid.

We believe that the time relationship is the important factor in differential diagnosis. With few exceptions dermatologists agree that a contact dermatitis should clear up within a short time, a few days to a few weeks, after the irritant is removed while a dermatophytid disappears only after the primary focus has healed If therefore the dermatitis of the hands fails to clear up or improve in a month or more after the patient has stopped working, and if there is at the same time soggy skin in the toe-webs containing fungi and if the eruption on the hands is localized and grouped rather than diffuse, and recessions and exacerbations occur in the same locations, it cannot fairly be considered an occupational dermatitis. (See chapter on Diagnosis.) In this respect there is an advantage to the physician who sees the patient some months after the onset of the dermatitis.

The pathogenic fungi capable of affecting the human skin are of numerous species, many of which are but little known and difficult to differentiate, although the clinical lesions produced by them are comparatively well defined

Monilia has been shown to exist saprophytically on the epidermis of the great majority of human beings, having been isolated from the nail grooves of 60 per cent of normal persons in one experiment. These apparently innocuous organisms become pathogenic in the presence of conditions favorable to their growth The optimum medium for monilia is the seborrheic type of skin subjected to warmth moisture and maceration. Thus, dishwashers, laundresses, bartenders, and domestic servants frequently develop lesions of the nails and interdigital webs by reason of their occupation.

The dermatophytes or pathogenic ringworm fungi do not appear to live saprophytically on the human skin, but the hairs of animals have frequently been found positive for these organisms in the absence of any apparent cutaneous lesion In these cases, the fungus may be transmitted to human beings associated with the carrier For example a cat has been known to infect 10 persons without itself showing any clinical evidence of disease Tests on the hairs of suspected animals should be carried out to determine the source of such infections.

Ringworm is one of the most widespread of the fungous diseases of human beings. It is produced by the various members of the *Trichophyton Microsporon* and *Epidermophyton* groups. *Trichophytons* attack chiefly the hair *Epidermophytons* the glabrous skin

and *Microsporons* both the hairy and glabrous areas. The varieties with which we are mainly concerned are as follows

Trichophytons

T endothrix
- (a) Violaceum
- (b) Crateriforme
- (c) Acuminatum

T neo-endothrix

T ectothrix
- (a) Small-spore variety *T gypseum* (T gypseum from horses and T gypseum from cattle frequently affect the beard in man)
- (b) Large-spore variety { *T niveum*, *T roseceum*, *T faviforme* }

T cerebriforme

T plicatile

Microsporons

M adouini, of human origin

M lanosum (caninum) of animal origin

Epidermophytons

E interdigitale—commonest cause of "athlete's foot

E inguinale isolated in Tinea Cruris and Dhobie Itch

One or more of these fungi may be found in ringworm lesions occurring on various parts of the body Their growth is favored by heat and moisture as in the interdigital webs of the feet

RINGWORM INFECTIONS

Dermatophytosis (Ringworm) of the Hands and Feet.—This type of ringworm may occur on the feet alone In its simplest form the infection is limited to the toe-webs which become scaly and may show superficial fissures. Maceration creates a white soggy thickened condition of the epidermis. The fourth interspace is most frequently involved although all the webs may show the presence of the disease Pruritus may be slight severe or absent Extension to the sides of the feet and the soles manifests itself usually as an outbreak of patches or vesicles or bullæ which may become purulent The vesicles and bullæ are usually tense and deeply situated in the skin and on drying or rupturing they become crusted and scaly Occasionally the lesions become yellowish-brown and keratotic from the heaping up of dried crusts. Such lesions may heal spontaneously or the area becomes moist and eczematized New vesicles often form around old drying patches.

Epidermophytons and *Trichophytons* are the predominant organisms found in the lesions of interdigital ringworm (Fig 101)

Individuals with ringworm of the feet may develop an allergic eruption of the hands. This takes the form of non-inflammatory minute clear vesicles along the sides of the fingers or on the palms and dorsa Ordinarily the vesicles form fine scaly patches and heal spontaneously only to be succeeded by new crops which go through a similar cycle Often well circumscribed patches of vesicles form

This differentiates such lesions from the diffuse eruption of a contact dermatitis.

Theoretically the dermatophytid is the reaction of sensitized skin to fungous elements which reach the skin of the hands through the blood stream from the foci on distant parts of the skin. The sensitized skin reacts with an explosive inflammation which destroys the fungi. The product is the vesicle. In other words this is a hematogenous process whereby the skin is sensitized by the fungi or their products.

FIG. 101 – Tinea on dorsum of hand of wool worker

Since the common dispute in the majority of eruptions on the hands—that of dermatophytid *versus* contact dermatitis—is exceedingly important in occupational skin diseases, we wish to offer the following criteria in differential diagnosis.

Dermatophytid	*Contact Dermatitis*
Location. Usually on the palms and sides of fingers.	On any part contacting the irritant, especially the dorsal surfaces of the hands.
Type eruption. Discrete vesicles or bullæ or in distinct groups and not on a diffuse erythematous base.	Closely aggregated vesicles or bullæ on a diffuse erythematous base, fading off onto the adjacent normal skin.
Recurrences. Usually on the same location.	On various locations depending on point of contact with the irritant.
Relation to occupation. Recurrent attacks usually on same locations, despite abstinence from contact with offending irritant.	Occurs on each return to work, after having previously cleared up.
Relation to fungous infection on feet, groin, or other location. Active fungous infection must be present.	No fungous infection present unless coincidental.

	Dermatophytid	*Contact Dermatitis*
Tests	Tricophytin test may only signify that patient had a previous fungous infection and therefore has no significance as to the present dermatophytid. The test may be negative before sensitization has occurred. The test is more often positive in patients with clinical active dermatophytosis of the feet than in those showing no evidence of the disease. Microscopic examination of scrapings where the focus is present in order to demonstrate fungi	Patch tests with the various ingredients the patient contacts in his work should be positive, with the causal agent. This, of course, should not be considered as a definite diagnostic point of causal relationship, but must be used in conjunction with all other factors.

So long as the foci on the feet remain active the allergic vesicular eruption of the hands continues to appear. It is the dermatophytids which are often mistaken by workers for a contact dermatitis of occupational origin and often give rise to diagnostic dispute on the part of physicians. The clinical appearance of well defined vesicular patches and the time relationship to work are the decisive diagnostic factors. (See chapter on Diagnosis.) Contact dermatitis is usually diffuse occurring on parts of the skin exposed to contact with irritants namely the hands forearms face neck, etc. An eruption which recurs weeks or months after the patient has not been in contact with the supposed industrial irritant can hardly be of industrial origin.

Tinea Circinata (Trichophytosis corporis, Herpes tonsurans, or Ringworm of the Body).—There are two general forms the dry and the moist. The dry or macular type, begins as a small red spot slightly raised above the surrounding area and spreads peripherally to form a ring. The center is covered with small scales, while the margins are red and may be slightly swollen with occasional transitory vesicles. The rings vary in size but seldom become larger than 5 or 6 inches in diameter. The outer border usually shows a slight white branny desquamation. Two or more concentric rings may be present. This form of lesion is most often found on the forehead and neck. It may be accompanied by slight itching or burning. (Fig. 102.)

In the moist or vesiculo-pustular type the vesicles may arise irregularly or in a ring just behind the margin which is red and edematous. These rapidly dry up and are replaced by crusts which are followed by spontaneous healing with an increase of pigmentation at the center. The appearance of pustules is usually indicative of infection of a hair follicle. Pruritus is frequently marked and scratching may lead to lichenification or to secondary infections. This type usually represents a more virulent fungus as well as the contributory effects of maceration and friction. The lesions most commonly occur on the back the abdomen the intermammary and submammary areas, and the inner surfaces of the arms and thighs

A *Trichophyton* or *Microsporon*, usually lanosum is the organism most frequently isolated.

Ringworm also occurs on the dorsal surface of the hands, where it is generally of the suppurating type resembling kerion of the scalp Sabouraud identifies the causative organism as *Trichophyton microides* of the *gypseum* and *niveum* types. These types of ringworm infection may be of occupational etiology in barbers and beauticians.

Fig. 102.—Trichophytoses from infected cows in a milker (Case of Drs. Foerster and Wisder.)

Tinea Cruris (Eczema Marginatum).—This variation occurs chiefly on the inner sides of the thighs and the perineum. It is exacerbated by heat perspiration and friction and hence is not uncommon among cavalrymen and others who spend much time on horse-back. It is caused principally by the *Epidermophyton inguinale* and is characterized by extensive exudation in bright red patches with an elevated scaling border distinctly marked off from the surrounding skin.

Dhobie Itch (Laundryman's Itch) is the name given to tinea cruris in India where it is very common

Treatment.—It is a known fact that where there are hundreds of remedies recommended for the cure of any disease there definitely is not one that is accepted as a specific or is of value in all cases. Such is the case with the treatment of dermatophytosis for which an extensive list of advertised topical applications, is well known by the medical profession and the layman The various formulas and lists of chemicals in the textbooks and the many articles written on this subject is common knowledge but still we have not found a panacea.

For this reason the treatment of dermatophytosis is a personal equation wherein every dermatologist uses his own judgment. We

feel that the best method of attack is to treat the clinical stage as is manifest at the time the patient is examined

When an acute vesicular eruption is present wet soothing solutions should be used such as cold boric acid Burow's solution potassium permanganate foot baths, Alibour water or painting with a 1 per cent silver nitrate solution Vesicles, bullæ and pustules should be opened before the applications.

After the acute inflammatory process is controlled a 1 per cent brilliant green (malachite) or a 5 per cent gentian violet solution should be applied We know these are non-irritating anti-parasitic agents and will control any secondary bacterial infections. They also will prevent lymphangitis and subsequent lymphedema from recurrent attacks.

The stage of desquamation and soggy skin should be treated with keratolytics. Here we wish to warn against the many irritating chemicals and preparations that have been advised. It is best to start with weak preparations in order to see whether the skin is sensitive to the medication A 2 per cent salicylic acid in 95 per cent alcohol or a 1 per cent chrysarobin in chloroform or half strength Whitfield's ointment will suffice as fairly efficacious therapy at this stage If well tolerated the percentage can be increased but we have found the weaker preparations will do We believe that limiting ourselves to just a few preparations the use of which we understand by long practice will give us greater satisfaction than trying everything that is advised in the literature today

For soggy skin in the toe webs, escharotics such as 10 per cent salicylic acid in 95 per cent alcohol 10 per cent chrysarobin in *chloroform* or *Dreuw's ointment* are a *few medicaments indicated* in these cases Care should be taken not to produce a dermatitis venenata Therefore, the patient has to be seen frequently in order to avoid any complications.

Eczematization and lichenification can be controlled with roentgen-ray therapy Dryness of the skin should be treated with the applications of a soothing emollient.

As to prophylaxis, drying the toe webs thoroughly and the use of a 5 per cent boric acid powder in kaolin is as good as anything we have tried

The shoes and slippers should be fumigated with a 10 per cent solution of formalin by wetting a blotter with the solution placing the blotter in the shoes and keeping them in a covered shoe box for forty-eight hours. These shoes should not be worn unless aired for twenty-four hours, otherwise a dermatitis venenata may result

In the treatment of the dermatophytid on the hands irritating applications should be avoided Fractional doses of roentgen-rays give good result in the acute or chronic stage in combination with wet dressings early and later with the application of a 5 per cent alcoholic solution of gentian violet or a 1 per cent aqueous solution of brilliant green covered with a thick layer of Lassar's paste or boric acid ointment and a snug dressing In the acute stage the

application of a mixture of crude coal tar (10) in chloroform may be substituted for wet dressings with excellent results. This should not be used for more than a week, since folliculitis occasionally results from the continual application of tar. As coal tar is a photosensitizer the patient should avoid exposure to the sun when applying this preparation.

YEAST INFECTIONS

The cutaneous affections caused by yeast-like organisms are almost as many and varied as those caused by the dermatophytes or ringworm. They occur chiefly in the interdigital webs, groins, internatal cleft, submammary folds, axillæ and nail folds and are similar to the lesions of ringworm.

Blastomycetes (yeast-like fungi), which are pathogenic both to animals and man, are responsible for many occupational fungous affections. Castellani has classified these organisms morphologically as follows:

Cryptococcus, having no mycelium and no asci.
Saccharomyces, having asci but no mycelium.
Monilia, having mycelium but no asci.
Endomyces, having both mycelium and asci.

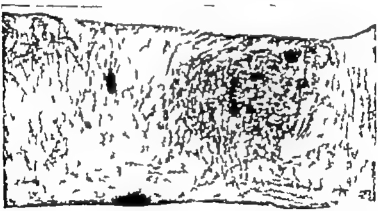

FIG. 103.—Blastomycosis in farmer. (Case of Drs. Foerster and Wieder.)

Blastomycosis (Blastomycetic Dermatitis, Saccharomycosis Hominis, or Dermatitis Blastomycotica).—This is one of the most formidable of the fungous infections, having systemic manifestations of a serious nature, as well as cutaneous lesions which may be either primary or secondary. The human form was first studied in 1803 by Carozzi, and since that time about 100 cases have been described by various observers. (Fig. 103.)

Cutaneous blastomycosis may be an occupational disease among agriculturalists and cattle handlers. It is a chronic inflammatory disease beginning as a small papule or papulo-pustule which becomes

crusted and slowly extends peripherally forming a well-defined elevated verrucous patch on a base infiltrated with pus. The lesion has a characteristic dark red sharply sloping border filled with minute deep-seated abscesses many of which are invisible to the naked eye while others reach the size of a pin-head. The larger abscesses are filled with thick, glairy mucopus, but from the smallest only a tiny amount of mucus can be expressed. Blastomycetes in both budding and mycelial forms have been obtained in pure culture from the exudate especially from the smaller abscesses. Similar abscess formation occurs throughout the lesion but those on the sloping border are the most characteristic and diagnostically significant.

In its early stages the eruption gives very little discomfort, and the patient usually does not seek relief for several months. When first seen by the physician the patch has probably grown to a diameter of 1 inch or more and is elevated from $\frac{1}{4}$ to $\frac{3}{4}$ inch above the surrounding skin. The surface has a cauliflower appearance with irregular elevations separated by clefts. The younger lesions near the border are generally rather firm and dry like an ordinary wart. The larger lesions may be partly covered by thick adherent crusts, beneath which are large lobulated papillary projections suffused with sero-purulent exudate. Some of these are very vascular and bleed at the slightest touch. The papillomatous surface in the older lesions is sometimes partly replaced by a thick scar like formation, which is irregular and may be corded but shows a smooth glistening pinkish surface. Occasionally the surface beneath the crust may resemble an ordinary ulcer with exuberant granulations.

The disease may remain indolent for months, or even years, then gradually extend until the lesion is the size of a silver dollar or even as large as the palm. As it extends peripherally the central portion tends to heal.

Healing, which is sometimes spontaneous, is first indicated by a flattening of the papillary projections and a decreased secretion from the base. The lesion takes on the appearance of an ordinary wart. In some cases, the papillary surface is replaced by the scar-like tissue described above and changes gradually to a regular scar. While most of the abscesses disappear during the healing process, active foci are frequently discernible even in the scar tissue after it has become thin and soft so that areas which are apparently well may again show active foci of infection. Hence, a single patch may at the same time show an advancing border, new lesions in old scars, verrucous elevations in different stages of development and recession, a base which is dry and firm in some places and in others soft and infiltrated with mucopus, and scar-tissue partly thick and rough and partly soft and unattached to the deeper tissues.

Etiology.—The causative organism is classified as a Cryptococcus (gilchristi) or an Oïdium (dermatitidis) and is a yeast-like fungus. The term Blastomyces is a very vague and confused one. Infection occurs through direct contact with the skin.

Many cases have a history of antecedent trauma, which may be contributory Exposed parts, such as the face, hands, wrists, and forearms, are most frequently attacked but no portion of the body is exempt.

In systemic blastomycosis, the lungs, liver kidneys, spleen, and sometimes the bones may be involved. Temperatures range up to 103° F the patient develops anorexia emaciation extreme weakness, and often anemia. Multiple subcutaneous nodules and abscesses, from the size of a pea to that of a walnut, frequently occur These can often be palpated before they become visible, but as they enlarge they come to the surface and rupture, discharging purulent material sometimes tinged with blood. Ulcers form at the site of rupture, occasionally with fistulæ leading into the deeper tissues. The fungus may be obtained in pure culture from the unruptured abscess. The prognosis is extremely grave, a mortality of 90 per cent having been thus far reported.

Diagnosis.—The cutaneous lesion is recognized by its sloping border studded with miliary abscesses, many of which are visible only under the magnifying glass, and by its sharp demarcation from the normal skin. The clinical diagnosis is easily confirmed by placing exudate from the abscesses, or a portion of teased tissue between a slide and cover glass with a drop of 20 to 30 per cent solution of potassium hydroxide. The presence of distinct budding organisms in the débris of tissue and pus cells establishes the diagnosis. Further confirmation should be obtained by culture of the organism and histological examination of the tissue.

Epizoötic lymphangitis is due to a cryptococcic farcinous Blastomycete transmitted from cattle to man.

Systemic blastomycosis is to be distinguished from coccidioidal granuloma, tularemia and sporotrichosis.

Treatment.—Numerous methods of treatment have been tried with varying success. Potassium iodide in large doses (as high as 200 to 400 gr daily) has been effective in many instances, but while this rapidly heals the major lesions, small lesions are likely to persist indefinitely and the infection flares up again when the treatment is discontinued In several cases reported by Ormsby and others, this treatment was partially successful and the remaining lesions were cleared up by the use of roentgen-rays.

A few cases have responded to copper sulphate internally in doses of ½ gr., and wet dressings of a 1 per cent solution. Others have benefited from arsphenamine, radium and injection of the filtrate of an autogenous culture. Curettage has been tried in a number of cases, but has been followed by recurrence.

The most effective methods so far reported are (1) complete excision of the diseased areas, after which no recurrence has been observed, and (2) iodine therapy supplemented by roentgen-ray treatment which appears to eradicate the infection completely

The lesions should be kept clean and antiseptic lotions or dry dressings applied General medical treatment is required in systemic

cases according to individual indications. The hygienic measures for blastomycosis are the same as for tuberculosis.

The organisms are present on various forms of vegetable matter and some animals, and are transmitted by direct contact. The disease is an industrial risk chiefly among outdoor workers and has been reported among farmers, horticulturists, straw cutters, paper makers, choppers of wooden packing cases, and persons who tend animals or handle their hides or refuse. A physician contracted the infection while performing an autopsy upon a patient who had died from systemic blastomycosis, and developed numerous repeated lesions accompanied by lymphangitis of the arm

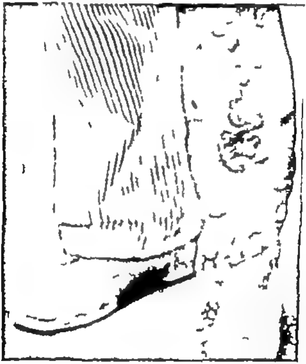

Fig. 104.—Chromoblastomycosis in a Puerto Rican farmer (Dr Carrion, Clinic San Juan, P R)

Chromoblastomycosis.—This infection which is histologically similar to blastomycosis, is due to a fungus first recognized by Lane in 1915 the *Phialophora verrucosa* This fungus does not grow by budding in tissue and has a dark brown color in culture

In the case described by Lane the lesions occurred on the buttock and closely resembled verrucous tuberculosis. Another case was reported by Wilson Hulsey and Weidman with papules violaceous nodules, crusted ulcers, and verrucous lesions some of which were fistulous, on the foot ankle and leg The affection had begun as an ulcer on the toe forty years previously The treatment is similar to that of blastomycosis.

In 1935 Carrion described 4 cases of fairly typical chromoblastomycosis, occurring in Puerto Rico which were caused by the *Hormodendrum pedrosoi*. (Fig 104) In a fifth case the clinical picture was a typical, and the infective agent was a fungus that had not previously been described. The lesion had been present on the wrist of an agricultural laborer for twenty years. It did not show the usual nodules or large vegetative tumors, but was more patchy psoriasiform less infiltrated and in places more or less papillomatous. There seemed to have been peripheral extension of old foci rather than the formation of new lesions as in chromoblastomycosis. The histopathological changes were, however indistinguishable from those of the usual form The fungus isolated was a *Hormodendrum* resembling *H pedrosoi* but its rate of growth in culture was much slower Its gross morphology was strikingly different and it was much more brittle. Due to the compact arrangement of the spores, the fungus was named *Hormodendrum compactum*.

Both *Phialophora* and *Hormodendrum* are genera of the *Dematiaceae hyphomycetes* but they differ widely in their cultural characteristics. Nevertheless, *P verrucosa* and *H pedrosoi* produce the same clinical syndrome. In *H pedrosoi* and *H compactum* the Phialophora type of sporulation occurred in fifteen strains from cases of chromoblastomycosis studied by Emmons and Carrion.

The same disease, probably has been described under the name "chromomycosis as presenting papules, nodules, and verrucous lesions. It is supposed to be transmitted through injury by vegetable fragments. Cases contracted from cactus spines have been reported in the United States. The following fungi have been claimed as etiologic agents *Botrytoides pedrosoi Phialophora verrucosa Macrospora Phialoconidiophora guggenheimia Hormodendrum* and *Dematium*.

Coccidioidal Granuloma.—This is chiefly a systemic disease closely resembling the systemic form of blastomycosis, but it may have a primary or secondary cutaneous form. It is caused by *Coccidioides immitis* and appears on the skin in primary lesions as papules, nodules, pustules, and vegetating papillomatous and verrucous lesions. The nodules are pink or dark red on breaking down they discharge a mucoid grayish-yellow pus containing the fungus. The secondary lesions consist of subcutaneous nodules, tumors, abscesses, and ulcers. Most of the cases reported in this country have occurred in the San Joaquin Valley California Tomlinson and Bancroft describe a case contracted by a medical student at the University of Nebraska while doing research work with *Coccidioides immitis* Jordan and Wiedman believe that the causative organism of the disease in South America is *Paracoccidioides brasiliensis* This was proved by animal experimentation the North American strain was virulent for all animals while the South American was not. Of the various methods of treatment that have been tried the best results were obtained by the use of tartar emetic intravenously and roentgen-rays externally and by intravenous or

intramuscular injection of colloidal iodine combined with instillations of tincture of iodine into the sinuses. The prognosis is grave except in those few cases in which the disease affects the skin alone.

Under the name of "valley fever" Dickson reports several cases of coccidioides infection. Four patients contracted the diseases in the San Joaquin Valley and a fifth in a laboratory. The diagnosis was verified by microscopic identification of the microorganism; in one case a positive intracutaneous reaction to coccidioidin, and positive animal inoculation. Skin manifestations were erythema nodosum-like swellings, associated with gastro-intestinal symptoms. Bronchopneumonia is a common complication.

Sporotrichosis.—Clinically this disease is characterized by the formation of indolent cutaneous and subcutaneous nodules, abscesses, and painless ulcers arranged in a line or chain along a lymph vessel. It may be occupational among agricultural laborers and others handling plant products. The infection often begins in a wound on the hand. The mucous membrane, muscles, and bones may become involved with the abscess formation. The causative organism is the *Sporotrichum* which may be transmitted to man by the handling of *Berberis thunbergii* (Barberry bush). Potassium iodide is the specific therapy. The lesions clear up promptly and do not recur.

Nocardiosis Cutis.—Clinically this disease is identical with sporotrichosis but it is caused by a different fungus. Lesions in the inguinal, perineal and upper gluteal regions have been described varying from the size of a pea to that of an olive, with necrotic ulceration. Actinomycetes were cultured from the pus. Intravenous injections of antimony and potassium tartrate combined with roentgen-ray irradiation locally cleared up the affection.

Actinomycosis (Lumpy Jaw).—The causative organism is the ray fungus. These organisms are parasitic on many kinds of plants and are pathogenic to animals and man. Most of the reported cases arise in open wounds or sores from contact with infected grain, although the disease may also be transmitted in rare cases directly from a diseased animal or through its milk or raw meat. Inoculation is frequently conveyed through a decayed tooth or through the respiratory or alimentary tracts, and it is only when it occurs directly on the skin that the disease may be regarded as cutaneous. The majority of cases in human beings are of occupational origin and occur chiefly among farmers, laborers, coachmen, grooms and millers. Treatment with potassium iodide in large doses internally combined with roentgen-ray irradiation locally has given the best results. Convalescent serum has been recommended. Actinomyces bovis is sensitive to penicillin and this has proven to be effective in a case seen by one of the authors.

Erosio Interdigitalis Blastomycetica (Intertrigo Saccharomycetica).—This is a mycotic infection occurring usually in the web between the middle and third fingers among kitchen workers and bakers. The skin becomes soggy, white, thickened and eroded,

with some erythema around the borders of the lesions. A yeast-like fungus can usually be cultured from the lesions. The disease persists if left untreated and rarely becomes systemic. Good results have been obtained from the application of chrysarobin 5 per cent in chloroform covered by a layer of collodion.

Mycotic Paronychia.—Mycotic paronychia is characterized by suppuration and erythema around the nail matrix, with dystrophy The nail-fold swells, and tiny abscesses form on the under surface of the nail wall just inside the margin from which drops of pus can be expressed. *Monilia albicans* and *Monilia pinoyi* are frequently found in the lesions in association with *Bacillus coli* and *Staphylococcus aureus* The condition is frequently seen among women who have their hands in water or syrups for long periods. Manicuring may be a contributory factor partly through trauma and partly through alkalis in the materials used. (See section on Nails.)

OCCUPATIONAL SOURCES OF FUNGOUS INFECTIONS

Animals—Domestic animals and poultry may infect man with various fungous diseases, often of a particularly virulent type. The *Trichophyton ectothrix* is communicable to man from horses, cattle, sheep pigs, deer cats, dogs and birds and also from hides and horse-blankets. This organism causes ringworm of the beard nails, and body but rarely attacks the scalp When the disease is contracted from horses and cattle the lesions are usually raised, well defined discs or nodules covered with pustules. Such infections heal spontaneously and the first attack appears to provide immunity thereafter The infection can also be transmitted from one human to another *e g* barbers may contract it from their customers. Workmen on stock farms, coachmen stablemen dairymen, and employees in the hide and leather industry are subject to direct infection.

The small-spored *Trichophyton ectothrix* occurs in dogs and horses, and the large-spored variety in cattle among whom the faviform type is common. From diseased sheep skins, shearers and sheep tenders may contract an acute suppurative sycosis of the chin and neck.

Cats, and sometimes dogs, are the source of ringworm infections. *Microsporon* is common among cats and when transferred to man produces well-marked inflammatory papular or vesicular patches. In one British Government Department, 194 women were affected by an epidemic of ringworm believed to be of cat origin. *Microsporon felineum equinum* and *lanosum* attack only the glabrous skin and beard in adults. The only *Neo-endothrix* communicable to man from animals is *T cerebriforme* Numerous cases have been reported in which ringworm was spread by cats and dogs in private families, and domestic employees may thus incur the infection as an industrial disease Workers in pet shops kennels, homes for stray animals, and veterinary hospitals are similarly subject to ringworm

Fowls, canaries and pigeons can carry a large-spored fungus, *T. rosaceum*, which attacks the scalp and beard in man, producing vesico-pustules, suppuration and kerion. Cultures of this organism are rose-pink in color. R. Prosser White cites the case of a woman who contracted favus from a pet canary which exhibited typical cup-shaped lesions on its head and neck. Pet-shop keepers, pigeon fanciers, workers on poultry farms, persons who dress, transport and sell poultry are exposed to such infection.

Mice are frequent carriers of fungous infections, particularly favus. The organism is most often *Achorion quinckeanum*. In Australia plagues of mice have been coincident with epidemics of fungous infections in human beings. An instance is reported from Amsterdam in which girls employed in a clothing store developed a very persistent eruption on the hands from which *Achorion quinckeanum* was isolated. Mice caught in the establishment showed whitish spots on the head, and cultures from these yielded the same fungus. Numerous cases have been published reporting favus contracted from mice by infants and children.

Blastomycosis occurs in persons whose work brings them in contact with animals. Ravogli has reported cases of this disease in two stable boys, two sheep breeders, a laborer in a slaughter house, and a colored woman cowherd.

Sporotrichosis has been observed in the horse, the mule and the dog, and a case is on record in which a boy contracted it from tending a cow.

Plants.—Yeast-like organisms are most commonly transmitted to man from vegetable matter. Straw cutters and paper makers, farmers, horticulturists and wood choppers are subject to blastomycosis from contact with the materials of their work.

Peasants working in the beet fields in the neighborhood of Prague have been affected with blastomycosis of the hands and feet, and true *Blastomycetes* have been cultivated from the surface of the growing beet-plant. Grain has also been reported as a source of infection.

Sporotrichum grows on many plants, from which it infects the hands of persons cultivating or otherwise handling them, usually through a break in the skin. Farmers, horticulturists, and grain or malt handlers are subject to the infection, and less frequently florists, berry pickers and potato handlers. A number of cases of sporotrichosis have been reported among gardeners, ten instances having occurred in one Wisconsin nursery from handling the barberry shrub. A housewife is reported to have developed the disease from picking straw. Sulphonamides have proven efficacious in sporotrichosis.

The *Actinomycetes* grow on herbs and grain, and can infect any open sore. They are able to remain virulent for more than a year on vegetable matter. A woman laborer who cut her hand while peeling potatoes, developed actinomycosis which remained localized at the site of the wound. A more serious affection was reported in

a woman who worked in a wheat field and had charge of cattle. In tying up sheaves of wheat her skin was pierced by a spike of the plant, and a painful edematous lesion developed around the wound. This was followed by vesicles and abscess formation, and later by deep sinuses and crateriform ulcers. The condition culminated in periostitis and bone necrosis.

Fruits.—Workers who handle fruit in the canning industry are subject to monilial infections resulting in interdigital erosions and chronic paronychia. Picking, peeling and coring fruits such as pears, apples, and strawberries give rise to a mycotic eruption from a yeast fungus whose exact classification is not known. Kingery and Thienes report that one-third of the employees in canning factories contract a suppurative paronychia during the pear season, with frequent loss of the entire finger-nail.

Sutherland-Campbell in 1920 demonstrated a variety of onyxitis among workers engaged in pressing oranges by hand for commercial orange juice. The oranges which caused the infection were of an inferior grade known to the trade as "culls," and were shrunken and discolored by the action of the infective organism. The lesions attack the nails of both hands, which first showed punctiform erosions and later became yellow and friable. The surrounding skin was red and swollen. The lesions were painless except on pressure, which in some instances produced pus from the ungual groove. Sutherland-Campbell attributed the condition to a parasite which he considered a spore form of a toadstool belonging to the Mucoraceæ. The periungual lesions were similar to those reported by Kingery and Thienes, who isolated yeasts of the Monilia type in their cases.

Onychia among workers in the manufacture of crystallized fruits, who are subject to constant maceration of the hands in hot and cold water, fruit juices, syrups, and sugar, has in some cases been attributed to a yeast fungus. (See section on Nails.)

Molds capable of causing a rash on the forehead, face, the dorsa of the hands, and the scrotum may be conveyed to the skin of workers among plant and vegetable materials.

Sorters and packers of dried fruits are subject to cutaneous irritation from molds. Several cases have been reported among women in the Orient, who developed an itching infection of the wrists by rubbing against the sacking on the tables which contained the fruits. The mold isolated was the *Cereosporella texans*, which resembles the *Trichophyton asteroides*.

A black, powdery mold coats the macerated dry stalks of sugar cane and produces eruptions of the skin in some of the workmen who handle it. A white mold affects basket makers who split, hammer, and cut the calamus rotang, or calamus draco (the Elanewel of the West Indies), which is supposed to contain the resin called "dragon's blood." Numerous painful fissures develop on the skin, chiefly in the palms and fingers, with cracks running longitudinally, but never in the transverse creases.

A white powder from the canes or rhizomes of large reeds of Prov

ence (*Arundo donax*) which are used in the basket trade and also as laths in the ceiling of houses, can cause cutaneous eruptions in workers who strip the bark from these canes. The irritation is generally accompanied by fever headache slight lumbago and sometimes conjunctivitis, rhinitis pharyngitis, and even acute bronchitis. The cutaneous lesions begin with erythematous plaques and slight swelling In a few days groups of fine, more or less confluent, vesicles appear which are later replaced by crusts. Rarely they become pustular Serra has demonstrated that the eruption is due to the spores of a toadstool which develop in the canes when they are piled up in humid places. He has classed this toadstool in the family of *Ustilaginæ*, under the name of *Ustilago hypodites* which some authors consider to be *Sporotrichum dermatodes* This occupational risk can be avoided by sprinkling the canes with water to prevent dissemination of the mycotic dust.

A similar eruption often occurs among workers who bind or vend hay straw or rushes, and among persons making cane-bottomed chairs, or wrapping bottles in matting This is thought to be due to the *Scopulariopsis koningii* which occurs in litter manure and straw

Raw cotton is frequently contaminated by dust containing molds. The cotton tester must put his hands far down into the baled raw cotton to remove a sample, and the dust arising from it may create a transitory rash Cotton sorters are also exposed to this affection.

Mycosis from *Aspergillus niger* or *flavus* has been said to occur in the external meatus of the ear among weavers, spinners wool sorters, paper mill workers, and laundry workers.

Miscellaneous Sources.—Fungi grow well on silk, wool and leather Ravogli reported the case of a cobbler who contracted blastomycosis from repairing shoes infected with the organism. *Scopulariopsis brevicaulis* is a fungus found on decaying and decomposing vegetation paper and leather It may infect the nails or produce a vesicular eruption of the skin deep lesions such as nodules, granulomata, or an ulcerative process such as was recently described by Markley Philpott and Weidman.

Wooden floors and fixtures, brushes combs, bathtubs, towels, and clothing may transmit ringworm and other mycotic infections.

Continuous immersion of the skin in contaminated water may give rise to mycoses. The lesion usually shows grouped herpetic vesicles surrounded by a red ring and possibly pustules. Rupture of the vesicles discloses a red weeping surface which is followed by scaling L. I Schwartz reports 12 cases of paronychia among housewives, domestic servants, and dishwashers. Monilia was found although he does not claim that this organism was the causative agent. Roetter mentions 12 washerwomen affected by an erythematous rash in which a yeast infection was the probable cause, aggravated by continual maceration and irritation from strong alkalis and fats contained in the soaps Sores on the hands of charwomen bar tenders, waiters, and dishwashers may become infected with fungi.

Dodge cites the occurrence of interdigital blastomycosis among paper workers in the province of Gifu. In the manufacture of *mino* paper the workers keep their hands in water practically the whole day. The paper made from the bark of *Broussonetia papyrifera* Vent. or *Quercus glandulifera* Blume, and bleached with $Ca(OCl)_2$, is washed with water and then a maceration of the root of *Hibiscus japonicus* Miq. or *H. manihot* L. is added to the slime which holds the paper fibers together to make it suitable for use in making umbrellas. Of 50 workers examined, 30 had interdigital blastomycosis of the hands. The same fungus was isolated from the raw root of Hibiscus, from the preparation used in paper making, and from the lesions of the paper makers.

Complete destruction of the finger-nails has been reported among employees in breweries who scrape off masses of yeast from fermenting casks with their nails. Crusted growths form under the nails, which produce numerous lacunae. (See section on Nails.)

Wood may harbor and transmit various fungi to man. A case of sporotrichosis occurred in a carpenter who mended the manger of an infected horse. R. Prosser White reported cases of sudden acute erythematous rash on the face, hands, and arms in 2 porters in an infirmary who swept a cellar containing a large amount of dry decaying wood. The lesions were believed to be due to the dry-rot fungus.

Urticarial itch among dockworkers handling logs of African mahogany (*Runguo*) wood was reported by Mense. The eruption was produced by hyphomycetes which infested the bark, and no longer occurred after these fungi were destroyed by steam.

Blastomycosis has been reported among wood choppers engaged in making packing cases in this country.

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CHAPTER XLII

OCCUPATIONAL CANCER

By occupational cancer is meant the cancer which results from exposure to cancerigenic forces, substances, or which appears at the site of an occupational trauma. Malignant occupational tumors are nearly always carcinomas. Only rarely (radium cancers of the bones) are they sarcomas or endotheliomas. Henry reports among 1 477 fatal cases of malignant growths of the scrotum only 12 sarcomas and 1 teratoma. Occupational carcinomas of the skin are usually of the basal and squamous cell type. Environment insofar as it is a necessary part of the occupation may be regarded as a cause of occupational cancer. If a worker because of an occupational environment, insists on drinking or eating water and foodstuffs, containing cancerigenic agents and subsequently develops cancer due consideration must be given to this fact in establishing the etiology.

The occupational etiology of a carcinoma must be considered if a forced occupational environment entails an actinic ray exposure or an exposure to other known carcinogens such as tar or radium or to infections with parasites such as schistosoma which may cause bladder tumors. The largest group of occupational cancers are caused by exposure to cancerigenic chemicals.

The following is a list of suspected cancerigenic chemicals:

Actinic rays
Alpha and beta naphthylamine (bladder tumors)
Aniline
Anthracene oil
Arsenic (ingestion of inorganic)
Asbestos (chronic irritation)
Benzidine
Benzol
Chromates
Coal tar
Creosote oil (coal tar)
Crude and processed mineral oils
Mesothorium
Nickel carbonyl
Nitrates (reported from Chili)
Paraffin oil (crude)
Pitch (coal tar)
Radium and radio-active elements
Roentgen-rays
Saltpeter (Sod. 2 Pot. nitrate)
Soot
Trauma
Ultra-violet rays
Uranium

42

Malignant occupational tumors are nearly always carcinomas. Only rarely are they sarcomas or endotheliomas. Among 1 477 fatal cases of malignant growths on the scrotum studied by Henry only 12 were sarcomas and 1 was a teratoma

By occupational cancer is meant the cancer which appears as a result of prolonged exposure to carcinogenic substances or which appears at the site of an occupational trauma. Such cancers are usually prickle-cell epitheliomata Only rarely are they of basal-cell origin

FIG. 105.—Recurring papillomatous tumor on leg of rubber worker exposed to carbon black

It is recognized that certain substances have carcinogenic properties. These substances include the by products of coal namely tar soot, pitch anthracene etc. petroleum shale oil and its residues arsenic radiation such as roentgen-rays radium and the actinic rays of the sun (Fig 105)

Not all cancers occurring in workers who come in contact with carcinogenic substances, however are necessarily occupational There is a normal incidence of cancer among all human beings that must be taken into account

Occupational cancers have certain characteristics. They always appear on parts exposed to the carcinogenic chemical or agent (except the bladder tumors due to aniline and the lung tumors of workers exposed to radium)

Occupational cancers may occur precociously that is before the normal cancer age. They are often multiple are always heralded by a precancerous lesion, and appear in workers who have been exposed for a long time to carcinogenic agents.

Trauma as a Cause of Cancer.—Workers who are exposed to repeated minor traumatisms accompanied by infection or excoriation of the skin, or to various irritating agents such as acids, strong alkalis, and substances which burn and cause cicatrices may develop malignant growths at the site of such trauma. However it must be remembered that cancer when it occurs, is often attributed to faintly remembered blows and that blows are of common occurrence, while cancer at the site of trauma is so rare that it makes one doubt any causal relation.

Whether a single trauma can produce cancer is debatable. Schad says that cancer develops in less than six months after an injury Juillard cites one case that occurred sixteen days after a puncture by an iron fragment. Werner and Blumenthal say that a single injury seldom causes tumor except where a chronic inflammatory process has its inception at that time.

In order to attribute a case of carcinoma to trauma, the whole occupational history must be carefully taken. It must first be shown that the part was normal before the trauma occurred that the trauma if a single blow was a severe one and included the site of the tumor that a sufficient interval has elapsed between the occurrence of the injury and the appearance of the tumor and that a biopsy verifies the carcinomatous nature of the tumor (Fig 106)

Chronic irritation however must be considered as a possible cause of occupational cancer (Fig 107) To prove this, R Prosser White states that the mechanical irritation caused by the ropes attached to the right horn of cattle drawing carts in India causes cancer These ropes are usually impregnated with tar which may be a contributing factor R Prosser White also reports cancer of the tongue in a boot repairer caused by the irritation of holding tacks in his mouth The chewing of betel nuts is said to produce cancer of the cheek among Orientals. Eilers records a case of carcinoma of the palm of a dairyman which developed after many years from the irritation of milking

Cancers can arise in cicatrices and especially those following burns. (Fig 108.) They can develop as early as thirty days after a burn although such an early appearance is rare P Toro and H Itoh report 6 cases of cancer that occurred in the scars of burns. The average elapsed time was six years after the burn and the average age of the patients only twelve years. However the age of the scar is more important so far as the occurrence of cancer is concerned than the age of the individual because cancer usually occurs in old scars.

Heat itself is not regarded as a keratogenetic agent but when associated with ultra violet radiation or scar tissue or trauma it might well be so. Oppenheim attributes epithelioma of the legs of railway stokers t the heat of the firebox and to whatever trauma the leg might incur The kangri cancer occurring in Kashmir is said to be due t the custom of carrying an earthenware bowl containing hot charcoal against the abdomen. This bowl called "kangri is

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Carcinoma has also been reported in scars resulting from chemic burns. Gougerot and Burnier report a case of epithelioma of t cheek following contact with a drop of carbon bisulphide

FIG. 108.—Twenty years before this man was burnt with blasting powder granu still remaining in the skin of the ear The penned outline below is the size of t glandular enlargement

Actinic Causes of Cancer—Cutaneous cancer is relatively com mon among the rural population Laborers of northern extractio living in a tropical climate are prone to develop carcinomato lesions of the skin. Such changes are rare in negroes.

According to Young and Russell in England fishermen head th list of cancers of the face and ear and sailors, soldiers and farme come next in order In the United States, Keller and Stephenso state that the peculiar condition of life in the open air exposu to the sun and salt water among sailors in the United States Nav are associated with the frequency of cancer of the lip and skin eig times more than normal and that the mortality from cancer

Cancers arising in roentgen ray and radium operators doctors nurses, orderlies laboratory workers and technicians are of fairly frequent occurrence although according to Saunders and Montgomery who collected 250 cases of roentgen-ray and radium dermatitis, among which were 27 epitheliomas, the large majority of injuries from roentgen-rays and radium are now contracted through therapeutic rather than occupational exposure. They state that the more extensive the injury to the skin the more likely is cancer to develop and that it develops with equal frequency from ulcerations and from keratoses. (Fig 100)

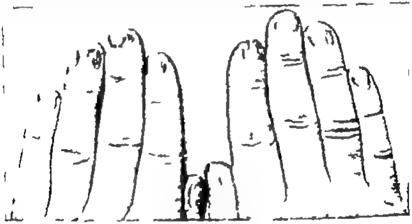

Fig 100 —Radiodermatitis (occupational) in a physician (Collection of Dr Howard Fox.)

Injuries of the skin from radium and roentgen-ray consist of superficial inflammation which reaches its height about fourteen or fifteen days after exposure It may be followed by atrophy chronic ulcer keratosis, and malignancy

Radium caused necrosis of the jaws of workers exposed to its action such as the painters of illuminated watch dials who put radium compounds on the dials to make them luminous. Most of the dial painters who have been affected were in the habit of pointing with their lips the brushes that had been dipped in the radium paint Cancers of the lungs and the bones have also occurred among such workers, as reported by Martland and Flinn

Mesothorium and Uranium salts are also radioactive and capable of causing malignancy

Cancer of the lungs occurs with unusual frequency among the workers in the Joachimstahl mine where pitchblende, from which radium is extracted is mined The average span of life of these miners is only forty two years as compared with fifty nine years in the general population. A similar condition is reported among the cobalt miners of Schneeberg where it is attributed to inhalation of the dust which contains cobalt and arsenic as well as radium emanations.

Chimney Sweeps Cancer.—This condition has been reported in England more frequently than in any other country. According to Henry, 147 cases, or 10 per cent of the fatal cases of cancer of the scrotum during the years 1911 to 1935, occurred among chimney sweeps. It is said that the incidence of cancer among chimney sweeps is eight times as great as in the general population.

Chimney sweeps cancer is of the prickle-cell type and develops from a papilloma of the scrotum. Metastases are rare. It is said to be due to the local irritation and rubbing in of the soot as the sweep is cramped in descending the chimney. Cancer deaths among chimney sweeps prior to the age of forty-five years are due to cancer of the scrotum. The chimney sweep usually begins his occupation when he is still a child and fits easily into the chimney. As he grows older and larger, however, it becomes increasingly difficult to go down the chimney, and with increased friction the soot is rubbed more and more into the skin.

Fortunately the condition is now on the decline in England and is reported to be practically non-existent in other countries except for an isolated case or two in Germany.

Tar Cancer.—Coal tar and its derivatives are the most frequent causes of occupational cancer. In the United States 35 per cent of all occupational cancer is caused by tar, 54 per cent by pitch, and 5 per cent by heavy tar oil.

Tar and pitch derived from gas works are said to be more carcinogenic than those derived from coke ovens. Tar and pitch from gas works account for 70 per cent of all cases of tar cancer in the United States, while the same substances from coke ovens account for only 5 per cent. Negroes are said to be less susceptible to tar cancer than white men.

Coal tar is keratoplastic and because of its phenol content is also anti-pruritic. Its keratogenic properties are due to chemical action rather than to physical irritation. The carcinogenic substances are contained in the distillates which come off at a high temperature. Anthracene oil is the principal high-temperature content of coal tar. Pure anthracene, phenanthracene, carbazol, fluorene, and acridine are said to be non-carcinogenic. Benzopyrene 3, 4, an actively carcinogenic agent, is present in English coal tar to the extent of 0.003 per cent. A number of substances which can be derived from anthracene but which are not actual constituents of coal tar have been found to be active carcinogenic agents. Dibenzanthracene 1, 2, 5, 6, and a yellow aromatic hydrocarbon of the anthracene series, called Methylcholanthrene, which can be obtained from the bile acids, are the most powerful of these.

The incidence of occupational carcinoma among workers with tar and pitch is very high. Oppenheim found 4 cases of epithelioma among 24 men who had worked over ten years in a tar factory. Noviello noted 5 cases among 200 pitch workers. The authors noted 5 cases among 100 workers in a plant manufacturing pitch impregnated paper conduits.

Occupational carcinomas caused by tar have been reported among workers other than those engaged in the manufacture of tar and pitch. Weiss reports carcinoma of the hand in a man who worked for thirty-eight years at impregnating hemp rope with tar. Sambaugh reports 8 cases of cancer of the lip in fishermen, which he attributes to the tarred ropes and nets which they place in their mouths while at work.

Tar is used in building roads and in making roofing paper and felt, and pitch is used for making conduits, lacquers, insulating material, greases, and mineral cements, and workers at these occupations are affected with comedones, tumors, warts, keratoses, and epitheliomas, mostly of the scrotum, lip, face, and hands.

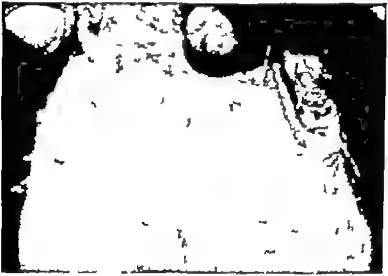

Fig. 110.—Scrotum—coal tar pitch worker. Showing results of radium treatment for epithelioma.

Briquettes are made by mixing together pitch and coal and pressing them in molds to the desired size and shape. Cancer of the scrotum is a frequent occurrence among briquette workers. (Fig. 110.) In Holland, W. M. de Vries reported 4 cases of cancer in briquette workers, and 10 cases of scrotal cancer were found among 2,500 Prussian briquette workers. The mixers, heaters, and pressers of briquettes are said to be particularly affected. Briquettes are rarely made or used in the United States.

Pyridine, an ingredient of coal tar, is also reported to be carcinogenic.

Aniline Cancer.—Workers in the manufacture of synthetic dyes are reported by Gehrmann of the United States and many German writers to be affected in unusual proportion with papillomata and carcinoma of the bladder. There is a general agreement that benzidine and beta naphthylamine are the chief carcinogenic agents in

these factories. Various writers have named aniline rhodamine fuchsin and alizarine as causes of cancer but have not proven the statements. Hamilton Hanna and Stallybrass say that arsenic contamination probably plays a rôle in the so-called aniline tumors, but give no evidence to support the theory

Petroleum Cancer —Workers with petroleum oils are subject to occupational carcinoma Oils from different fields vary in their carcinogenic powers. It is reported that 50 per cent of shale oil workers suffer from dermatoses and that epitheliomas occur at the rate of 1 per cent per annum among them

Twort says that the carcinogenic powers of oils rate as follows, in descending order Shale, Venezuelan Borneo Rumanian, Persian, Californian Mexican Mid-continental Texan, Pennsylvanian and Russian. He believes that benzenoid hydrocarbons in oils are carcinogenic, and that treatment with sulphuric acid or by oxidation and reduction processes or refining almost totally destroys the carcinogenic properties of oils.

Pure medicinal oils are not carcinogenic and pure mineral and vegetable oils have failed to produce experimental cancer in mice. It is said that the higher the ratio of the refractive index to the density of the oil the greater the carcinogenicity The fluorescence of mineral oils is also said to be an index of their carcinogenic powers the greater the fluorescence, the greater the carcinogenicity

Workers on the filter presses which extract unrefined paraffin from petroleum oil are subject to papillomas and carcinomas. H B Wood states that pure paraffin is not productive of cancer and that the tumors caused by oil liquid petrolatum and paraffin infections are not neoplasms, but foreign body granulomas [illegible] authors have noted that workers with refined white paraffin [illegible] suffer from the dermatoses, keratoses, and papillomata [illegible] those who handle crude paraffin

Mule Spinners' Cancer —Southam and Wilson in 1922 [illegible] called attention to the excessive occurrence of cancer of the [illegible] in mule spinners. This type of cancer is caused by the [illegible] against the scrotum of overalls soaked with mineral [illegible] spindles on the mule frame. Women are not affected [illegible] 70 per cent of all cancers among mule spinners are on the [illegible] Henry reports 574 cases of cancer of the scrotum [illegible] mule spinners in England during the period of 19[illegible] 288 cases of cutaneous cancer on other parts of the body [illegible] to 1935 He reports 343 deaths from cancer among [illegible] and estimates that 0.25 per cent of all cotton [illegible] England suffer from scrotal cancer F L. Hoffman [illegible] the United States during the year 1926 there were [illegible] cancer of the scrotum of which 3 of the victims were [illegible] and 3 were mule spinners. Four of the 6 were born [illegible] the other 2 in Canada which tends to show that [illegible] cancer is rarely contracted in the United States [illegible] particular form of carcinoma have been reported [illegible] in France

Germany Russia or Poland. In a woolen mill in the United States, employing about 200 mule spinners, an examination by the authors failed to show any cases of scrotal carcinoma

Arsenic Cancer —Arsenic is also keratogenic, especially on ingestion. Carcinoma has been reported as developing on the site of keratoses occurring in miners of ores containing arsenic. The ingestion of arsenic in such form as Fowler s solution is sometimes followed by the appearance of keratotic lesions and warts on the hands, palms, soles, and trunk, some of which may develop into superficial epitheliomas.

O Donovan reported [illegible] cases of epithelioma among workers manufacturing sheep dip which contained arsenic. Arsenic has not been reported to give rise to cancer of the internal organs. The authors cannot find any records of occupational cancer attributed to arsenic in the reports of the State Compensation Boards. We have noted skin cancers on farmers which the physician had diagnosed as due to arsenic merely on the fact the farmer uses arsenical insecticides. The age of the farmer and his outdoor exposure was not given due consideration

Fig. 111 Face of coal tar pitch worker showing result of radium treatment of epithelioma.

Occupational cancer of the scrotum has been reported among laborers by A. Richerand in 1815 by J Wolf in 1911 and by C L. Bayle in 1833 the latter having reported it as occurring among workers in lead R Prosser White however is inclined to doubt the occupational etiology of these old cases.

Occupational cancer attributed to irritation by lime chrome halogen compounds, alkalis and acids is rare

PREVENTION OF OCCUPATIONAL CANCER

In occupations where there is exposure to physical and chemical carcinogenic agents, workers should have a preëmployment examination and those found to be affected with warts, keratoses, or xeroderma should be rejected. It is preferable to select persons with dark skin and of cleanly habits.

In the factories where processes are employed that cause tar fumes or pitch dust to be given off the operations should be totally enclosed. If this is impossible, there should be adequate suction hoods over the work so that the employees will not come in contact with air laden with carcinogenic substances. The workers should be furnished with clean work clothes daily and compelled to take a shower bath at the end of each shift. They should be told to avoid touching the face or scrotum with tar-soiled hands.

Protective ointments may be useful especially when it is necessary to ward off excessive sunlight. Castor oil mixed with such photo-desensitizers as quinine, menthyl salicylate, pyrocatechine and zinc oxide has been used with benefit in such cases.

There should be frequent medical examinations of the workers and prompt treatment by excision or irradiation of all suspicious tumors. Treatment by roentgen-ray or radium is to be preferred to surgical excision, and excision of the neighboring glands is rarely necessary (Fig 111)

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CHAPTER XLIII

OCCUPATIONAL DISEASES OF THE MUCOUS MEMBRANES

INDUSTRIAL dermatology includes, besides the affections of the skin lesions and stigmata of the mucous membranes of the mouth nose and eyes. With this in mind the authors have thought it advisable to deal concisely with these subjects from a general industrial aspect. In order to avoid repetition in the various trades and industries where similar lesions may occur reference to this chapter will be made throughout the book.

With the large infiltration of workers into a variety of industries, we note a greater percentage of mucous membrane involvement than heretofore reported Ulcerations or inflammation have been seen on mucous membranes in much the same manner as they are produced on the skin from contact with essential irritants or from sensitivity to them Exposure to liquids and powders (or their sprays) gases and fumes, can produce an inflammatory process on the eyelids, conjunctivæ nares, lips and buccal membrane.

Mucous membrane irritation can be produced by deposits from the dust of asbestos cadmium chromium cotton cereals, powdered dyes, explosives flour grain manganese, pollen, tobacco wool and all toxic metallic dusts. It will result from contact with organic dusts from brooms, carpets cotton furs hemp rags, etc. We have also seen inflammation of the skin from these sources. The inorganic dusts such as arsenic, lead mercury are irritants and can be toxic by absorption All these aforementioned ingredients may act as chemical or mechanical irritants on the mucous membrane of the mouth nose or eyes.

The oral cavity is protected against innumerable external irritants by a rich blood and lymph supply strongly built stratified squamous epithelium and freely flowing saliva The saliva possesses little, if any inhibitory power upon the growth of bacteria.

Oral manifestations occur in association with various industrial diseases such as anthrax, glanders actinomycosis, foot-and-mouth disease and syphilis and also through the direct action of chemicals, dusts fumes and insect bites.

In some constitutional diseases the oral lesions may be diagnostic as in cases of lead poisoning of which about 70 per cent exhibit the well known lead line along the gingival margins.

Erythema and primary lesions in the mouth such as papules, wheals, nodules tumors vesicles, bullæ and keratoses may occur These undergo rapid changes due to heat, moisture and trauma and for this reason may present some difficulty in diagnosis. It is usually the secondary lesions that are seen by the physician in the form of erosions, fissures ulcers scars, desquamation, and crusts.

Diseases of the mouth may in turn lead to constitutional diseases. For example, alteration in the oral secretions and associated pyorrhea, etc. produce gastro-intestinal disturbances and the inability to eat solid food may cause avitaminosis. Rheumatic pains, spondylitis, and other general disturbances often result from secondary bacterial infections of the mouth

Disturbances of the oral mucosa may be conveniently divided into gingivitis, stomatitis and gingivo-stomatitis. These may be erythematous, exudative pseudomembranous, membranous, erosive or ulcerative in character The cause may be classified as being mechanical physical infectious, or chemical.

Abrasion of the teeth may occur after exposure to dust encountered by polishers and blasters, abrasive powder workers, and stoneworkers, or may be produced among garment workers, carpenters and cobblers, due to foreign bodies in the mouth (nails, pins etc.)

Catarrhal Stomatitis.—This is an acute or chronic inflammation of the mucous membrane which may occur among workmen from the inhalation of irritating dusts or fumes. Sand-blowers glass cutters, hop packers, and workers exposed to hydrochloric, nitric, and other acids may be affected. The condition is also seen in cases of poisoning by such chemicals as mercury lead arsenic, bismuth iodine and bromine.

The entire oral cavity including the vermilion border of the lips may become a deep red or bluish-red color without ulceration or areas of necrosis. The cheeks and the floor of the mouth are usually but slightly affected. The mucosa of the other areas becomes swollen, moist and bleeds easily The tongue is enlarged and covered with a thick grayish-brown fur If the temperature rises, the tongue becomes dry and crusted Food epithelial débris, and bacteria usually collect in the lower gingivo-buccal folds and give rise to a foul breath The condition is not painful. In severe cases the mandibular lymph glands become swollen and tender

Catarrhal (or Marginal) Gingivitis.—This is a similar condition restricted to the gums when teeth are present. Calcareous deposits may be found in the gingival crevices together with other débris.

Treatment consists in the removal of the deposits and the use of mild antiseptic solution After the mouth has been thoroughly cleansed it should be painted with Talbot's iodine-zinc iodide or other iodine solution.

Hypertrophic Gingivitis.—Inhalation of dusts in such occupations as sand-blowing glass-cutting etc may produce a hypertrophic gingivitis characterized by painless enlargement of the gums chiefly at the margins. The papillæ appear bluish-red swollen, and moist. They can easily be lifted and bleed at the least injury Under the papillæ there is usually a heavy dark-colored incrustation of subgingival calculus.

Treatment consists in removal of the workman from contact with irritating dusts and the application of Talbot's modified iodine solution to the affected parts. In very resistant cases, it may be

Butcher's Pemphigus.—This is manifested in the mouth by transitory bullæ which rupture and leave denuded surfaces covered by a rolled grayish membrane

Noma.—Noma is an ulcero-membranous stomatitis which sometimes terminates in gangrene of the lips and cheeks. A disease that resembles noma sometimes occurs among those who handle cattle and is supposed to be due to the bacillus of diphtheria in calves. The necrotic process may spread to the entire cheek, chin tongue, etc. and result in death. A biopsy reveals the so-called noma threads" in the blood-vessels and around the muscle fibers. Electro-coagulation is the favored method of treatment.

Aphthæ.—Aphthæ are pinhead to lentil size yellowish ulcers surrounded by a red halo The lesions are painful. They arise from gastro-intestinal disturbances and are also seen in foot-and mouth disease

Hydroa Æstivale—Hydroa æstivale produces buccal lesions the lips palate and tongue may be the site of red superficial erosions covered by a dirty gray membrane It is a recurrent summer eruption

Pellagra.—Pellagra presents oral lesions consisting of bullæ which rupture and leave eroded areas on the lips and tongue The tongue becomes red and beefy

Thrush.—Thrush caused by *Monilia albicans* consists of milky white adherent membranous patches on an erythematous base on the tongue or buccal mucosa

Actinomycosis.—Actinomycosis or *lumpy jaw* is caused by fungi of the genera *Nocardia Actinomyces* or *Streptothrix* which are parasitic on vegetable matter of all kinds and may infect both animals and human beings The disease occurs among workers handling straw agricultural laborers packers, bottle wrappers makers of straw hats, baskets mats and chair bottoms laborers on earthworks, miners carpenters masons, stone dressers stablemen cattle and pigeon tenders butchers, slaughterhouse workmen knackers veterinary surgeons, workmen preserving meats, employees in grain distilleries granaries flour mills, tobacco factories starch *factories breweries and malting houses. In malting houses* a great amount of fine dust is scattered in cleaning the grain, and becomes a special source of danger

The oral cavity is frequently the primary focus of actinomycosis Some authorities claim that the disease is of endogenous origin since organisms resembling actinomyces have been isolated from the mouths of normal persons. Nevertheless, the present consensus of opinion is that the pathogenic fungi come from external sources and find an entrance through carious teeth infected tonsils, or any break in the skin or mucous membrane The habit of chewing grass or straw is believed to be largely responsible for inoculation although infected vegetable dust may also carry the organisms into the oral cavity Cases have been reported among shoemakers in

Austria infected through slight wounds of the lips and tongue sustained by holding an awl in the mouth

The disease is said to be of occupational origin in about 75 per cent of cases, and those most commonly affected are agricultural workers among whom the incidence is greatest during the harvest season.

The infection may involve the skin, the lungs, abdominal organs and other parts of the body but the head and neck are most often attacked the favorite site being the soft tissues around the lower jaw The primary lesion consists of a hard deep-seated, dusky-red nodule which eventually suppurates and through many sinuses discharges a sero-purulent fluid containing characteristic sulphur granules in which the ray fungus can be demonstrated microscopically Ulceration follows, and new nodules appear beside the ulcerating lesion and follow the same course. The disease is essentially chronic and may persist for years.

Oral lesions may occur alone or as part of a more general involvement. When the tongue is involved the first lesion is a painless nodule which gradually enlarges, softens, and ruptures spontaneously to discharge the pus containing the characteristic granules. This process repeats itself as the infection spreads to other parts of the tongue and the floor of the mouth

Sporotrichosis.—Sporotrichosis rarely affects the oral cavity but some cases have been reported of lesions occurring as hard nodules or gummas. These rapidly soften and break down producing a thick, whitish discharge and resulting in distinctly outlined yellowish-gray ulcers. The causative organism is the *Sporotrichum schenki* which enters through a break in the skin or mucous membrane It is found in the unruptured nodule, but never in the discharge from the abscesses. Animals particularly horses, may contract the disease but they seldom transmit it to man. Grain and shrubbery (especially the barberry shrub) are the chief sources of infection. The cutaneous lesions of sporotrichosis occur most often among field workers, gardeners, florists, fruit and vegetable dealers, berry pickers, etc. (See Mycotic Infections.)

Blastomycosis.—Blastomycosis has occasionally been reported to produce stomatitis, ulcers, nodules, sinuses and other clinical manifestations in the mouth. The following organisms have been implicated

Cryptococcus corpelli	Monilia ardoi
Cryptococcus gilchristi	Monilia candida
Cryptococcus gracilioides	Monilia macroglossiae
Cryptococcus salmoneus	Saccharomyces labialis

Scurvy.—Scurvy may attack explorers and seamen on long voyages if the diet is deficient in vitamin C The disease is characterized by ecchymoses of the legs, edema of the ankles, malaise and loss of weight. The mouth is affected only when teeth are present. The gums become bluish-red or blackish and spongy in consistency

Carbon Monoxide.—Carbon monoxide poisoning produces rose-red spots on the face and mucous membranes. Various cutaneous eruptions, swelling of the oral mucosa, fungoid gingivitis, inflammation of the pharynx, and ulcerative tonsillitis frequently occur during convalescence.

Chromium.—During the plating process a fine spray of chromic acid is given off and reaches the nasal mucous membrane. A painless swelling of the tissues occurs, which is followed by ulceration and perforation of the nasal septum. The condition is not disabling and the patient is often unaware of the destructive process. The oral cavity is in rare cases affected by a localized gingivitis around the upper front teeth.

Chrome salts used in making Danish and Swedish matchheads during the World War caused numerous cases of ulceration of the *mucous membranes among matchmakers.*

Alkaline bichromates used for hardening and preserving wood may produce an ulcerative stomatitis with yellow lesions on the tonsils and palate. These sometimes extend down to the bone and may resemble chancre of the palate. The nasal mucosa may also be involved.

Cyanogen Compounds.—Cyanogen compounds produce congestive hyperemia of the oral mucosa and pharynx, with constriction of the throat and an oppressive feeling in the chest.

Electricity.—Cases of leukoplakia have been reported among telegraph and telephone workers from testing charged electric wires in their mouths. Electric currents generated electrolytically by the metals of teeth fillings and the saliva have often caused non-industrial leukoplakia.

Effort. Glass blowers and players of wind instruments may develop swelling of the cheeks due to overstretching of the facial muscles. The epithelium of the mucous membrane becomes thickened and roughened, and shows whitish or grayish patches. The outer layer becomes macerated by saliva whose flow is increased by blowing, and finally becomes detached. The condition is usually painless.

Pneumatocele of the parotid gland may result from violent effort. The air penetrates through Stenson's duct into the parotid gland. Particles of food may pass through the enlarged duct and cause infection. Some glass blowers are said to be affected in this way.

The teeth of glass blowers may show a loss of enamel from contact with the blowpipe.

Grain and Straw.—Grain and straw carry pathogenic fungi into the oral cavity, particularly among field laborers.

Halogens (Fluorine, Chlorine, Bromine and Iodine), when present in high concentrations, irritate the nasal and oral mucosa, causing catarrhal and ulcerative stomatitis. Bromine and iodine vapor produce a yellowish-brown discoloration of the gums. An excessive content of fluorine in drinking water causes mottling of the tooth enamel often accompanied by brown stains.

Heat.—Substances heated to temperatures of 135° to 160° F., repeatedly applied to the mucous membranes of the mouth produce increased keratinization which may result in leukoplakia. Cases have been reported among glass blowers, and also among tea and coffee tasters.

Localized *burns* also may occur among glass blowers from the hot blowpipe, and among engine drivers and stokers from steam and hot air. *Explosions* which occur in many industries often cause burns of the nasal and oral mucosa through the inhalation of super heated air.

Insects.—Bites of various insects encountered in outdoor occupations frequently cause an acute glossitis with swelling of the tongue even to the point of protrusion beyond the teeth. There is pain, marked salivation and subsequent ulceration from pressure.

Laboratory Workers.—Laboratory workers may pipette solutions of primary irritants into their mouths with resulting acute stomatitis, etc.

Lead.—Lead poisoning is a widespread occupational disease, the substance being used in nearly 200 different industries in this country. Painters who use white lead are commonly affected. Cases have been reported by Prins and Greenbaum among shoemakers who habitually hold leaded nails in the mouth.

The "lead line" is a diagnostic aid in lead poisoning. This is a bluish-black line on the gingival margin of all the teeth which becomes more pronounced at points of chronic inflammation. Dark bluish patches may also be observed on the mucous membrane opposite a tooth covered with calcareous deposits. The lead line is rarely seen in a healthy mouth and is not present in an edentulous one. The patient notices a sweetish taste in the mouth particularly in the morning which is accompanied by a sweetish metallic odor known as the "lead breath" or *halitus saturninus*.

Lime.—Workers who handle chloride of lime may suffer from a moderately severe gingivitis with small ulcers. The dust of soda, lime and cement affect the nasal mucosa with catarrhal inflammation, polypi, ulceration, and perforation of the nasal septum. Among 600 cement workers, Koelsch has found nearly 27 per cent to be sufferers from such lesions.

Mercury.—Chronic mercurial poisoning causes gingivostomatitis and salivation, due to the combined effects of mercury and the oral bacteria. It is seldom observed in a clean mouth and does not occur in the absence of teeth. A history of contact with mercury in an occupation and a peculiar metallic taste in the mouth followed by profuse salivation should establish the diagnosis of mercury poisoning in the early stages. These symptoms are followed by inflammation and ulceration of the gums.

The dust of sublimate and fulminate of mercury in conjunction with sweat may cause irritation and grayish-blue ulcers of the lips and nostrils.

Mother of Pearl.—Besides respiratory and cutaneous maladies due to the dust of this material workers frequently suffer from a painful acute gingivitis accompanied by fever The teeth become loosened but without suppuration or necrosis of the tissues, and a subacute osteomyelitis of the mandible may develop and may eventually produce limited motion of the jaw The condition occurs most often among young men engaged in the manufacture of pearl buttons even those with perfectly healthy mouths and teeth may become affected Since the disease clears up readily when work is stopped the patient should be advised to change his occupation in order to prevent recurrence

Musicians.—Musicians who play wind instruments may develop inflammation and thickening of the lips from pressure of the mouthpiece and affections of the buccal mucous membrane due to effort. Bacterial infections of the mouth may occur through the use of an instrument previously played by a diseased person. Papillomata and hematomata of the lips and tongue have been observed in cornet players due to the continuous mechanical irritation from the mouthpiece

Nitrobenzene—This chemical is used in the manufacture of aniline dyes and explosives it is also used under the name of oil of mirbane, or oil of bitter almonds, in the manufacture of perfumes liqueurs and confectionery Many cases of occupational poisoning due to nitrobenzene are reported among workers in these industries. Oral manifestations consist of a greenish-blue discoloration of the mucous membranes, and sometimes a bluish-black line on the gums

Phosphorus.—Since white phosphorus has been largely replaced by the red variety for making safety matches, cases of phosphorus poisoning have greatly decreased The white variety is still used in some compounds employed in metallurgy in the manufacture of projectiles, smoke screens manure products, insecticides, rat poisons, in the paraffined strips of phosphorus paste made for lighting miner's lamps, in the composition of alloys, and for many other purposes. The striking surfaces of matchboxes sometimes contain phosphorus sesquisulphide which has been responsible for some cases of dermatitis among matchbox makers. The fumes of phosphorus attack the mucous membranes and particles may be carried to the mouth by the hands. The condition becomes chronic and three to five years may elapse before symptoms appear

The oral lesions usually start by way of a decayed tooth through which the chemical penetrates into the jaw chiefly the mandible First there is swelling of the alveolar process and loss of the teeth with accompanying periosteitis. Finally secondary suppurative osteitis may occur with necrosis of the bone At this stage there is profuse salivation a garlic-like breath odor and painful swelling of the mandibular lymph nodes Pus may drain into the mouth through the skin or into the upper jaw and thence into the brain

cavity Meningitis is a possible complication when the maxilla is involved

Incision drainage, and surgical removal of the sequestrum if performed early usually effect a cure. The lesions are said not to occur in a clean mouth Most modern factories provide oral prophylaxis and other protective measures for their employees, so that the hazard from phosphorus has been greatly reduced in recent years.

Radioactive Substances —Radioactive substances enter the body through inhalation of dust containing the chemicals or by ingestion of the substances themselves. In certain processes of the radium industry such as tubing and retubing the material repairing needles, containers, etc. the workmen cannot be protected against the dust or the emanations. Swallowing radioactive substances can be avoided, however This occurred chiefly among women engaged in painting luminous watch dials, who put the brushes in their mouths to point them. The particles which adhere to the oral mucous membrane caused local irritation but most of the paint is swallowed and later deposited in the bones, liver and spleen. In early fatal cases, severe leukopenic anemia is followed by necrosis of the mandible, maxilla, or both frequently infection complicates the picture

Symptoms of radium poisoning may appear from one to seven years after the victims have stopped working The slower and more chronic form presents mild anemia and moderate necrosis of the jaw bones with low-grade crippling osteitis at the sites of individual foci of deposit. The extraction of teeth may initiate a rapidly spreading necrosis in these cases. Osteogenic sarcomata sometimes develop after a number of years.

The prognosis in poisoning by radium mesothorium etc., is very poor since there is no way of eliminating the substances from the system or of altering their radioactivity

Treatment of the oral lesions consists chiefly of careful hygiene of the mouth and prevention of sepsis with surgical removal of sequestrum when indicated The anemia is treated in the usual way by liver diets, etc. Large doses of ammonium chloride have proved of some benefit by diminishing the amount of the deposits. Efforts are being made to increase elimination by administering parathyroid gland hormones to expel calcium and the radium with it. Afterwards calcium is added to the diet to replace that eliminated. Some progress has been reported with this method.

Prophylaxis is of the utmost importance. The International Labour Office reports no radium necrosis in the watch factories of France Germany Switzerland Belgium England and Australia, where painting is done with a stylet and the substance is not taken into the mouth

Silver.—In cases of argyrism the pigmentation appears first as a violet line with a metallic luster at the gingival margin which does not disappear under pressure. If the patient continues to be exposed to the metal or its compounds the pigmentation spreads

to the oral mucous membrane, and then to the conjunctivæ and scleræ.

Argyrism is caused by the dust of silver or by the fumes arising from various processes in which silver or its salts are used. The making of silver leaf and silver nitrate pencils is said to be the most dangerous source of absorption and deposit in the tissues. While the disease is rare in industry cases have been reported in these occupations and among photographers and workers who make silvered beads by hand

Soot, Smoke and Ordinary Dust encountered in various occupations may occasionally cause leukoplakia among workmen A few such cases have been reported.

Sulphur Dioxide.—Sulphur dioxide, hydrogen sulphide, hydrogen selenide hydrogen telluride, and ammonia even in weak concentrations may cause severe catarrhal stomatitis The worker experiences a burning in the mouth and constriction of the throat ulcers and hemorrhages may occur Astringent mouthwashes should be administered the ulcers cauterized, and the patient removed from contact with the irritant.

Thallium.—The sulphate of this metal is widely used as a rat poison for which purpose it is usually mixed with barley It has also been employed as an ingredient of depilatories. Poisoning from this substance has been reported in a number of cases. The constitutional symptoms consist of pain and weakness of the extremities, abdominal pain vomiting paralysis of the cranial nerves, strabismus and alopecia. In most cases there is severe gingivostomatitis profuse salivation and in some cases a purplish discoloration of the gums.

Tin "Picklers" may incur a chronic marginal gingivitis in which the crowns of the teeth disintegrate and break off leaving roughened and blackened stumps. The condition is caused by the acid fumes of the pickle.

Trauma.—Trauma from cuts, blows, etc. may occur in practically all occupations which are therefore not enumerated here. This may result in cicatrices, or in some cases the formation of retention cysts consisting of tense freely movable grayish elevations usually on the lower lip The sacs are filled with a thick glairy fluid that tends to reform after evacuation unless the sac is removed Surgical excision of the sac or destruction by cautery is recommended.

Breaks in the membranes of the lips or mouth give ready access to bacteria and fungi of every sort and may prepare the way for such infectious diseases as syphilis elephantiasis nostras, botryomycosis, and contagious pustulous stomatitis.

Trinitroanisol causes severe edema and inflammation of the mouth and pharynx.

Trinitrophenol (Picric Acid) used in the manufacture of explosives, causes catarrhal stomatitis, yellow discoloration of the teeth and irritation of the skin, conjunctivæ and nasal mucosa.

Vegetable Irritants.—Workers with *euphorbia, veratrine* and *pulsatilla* may develop inflammation of the buccal mucosa.

Ethereal oil of hops causes eczema of the lips, stomatitis and inflammation of the pharynx which may also involve the nose and conjunctiva.

Oil of turpentine contaminated with oil of pine irritates the mucosa and causes salivation.

Ethereal oil of mustard is reported to have caused the widespread painless decay of the teeth down to the pulp in a workman engaged in tasting the seeds.

In the bakery trade among candy workers and refiners, sugar can produce dental caries.

Flour is the active agent in producing calculus and periodontitis.

Tobacco workers are likely to suffer from acute and chronic gingivitis from tobacco dust. There are also cough, bitter taste and irritation of the eyes.

Workers in jute mills suffer from irritation of the mucous membranes due to inhalation of the dust. Pharyngitis is very frequent and adenoid vegetations often occur among women and children employed in jute mills.

Gingivitis and a vesicular dermatitis resembling herpes labialis are sometimes seen among basket makers and are due to holding little strips of wicker between the lips.

War Gases.—War gases, such as *chlorine, tear gas, mustard gas*, etc., may cause a diffuse inflammation of the mucous membranes when inhaled in the course of manufacture.

Zinc Chloride.—Zinc chloride causes ulceration of the oral cavity with dry white sloughs that adhere to the base of the lesion.

Treatment.—The latest addition to our armamentarium, such as the sulfonamids and penicillin, should be mentioned here. These drugs are of great value in treating many of the diseases of the mouth such as anthrax, actinomycosis, staphylococcic and streptococcic infections, and gas gangrene.

OCCUPATIONAL AFFECTIONS OF THE EYE

The increase of modern industrial processes has introduced greater toxic hazards, and those affecting the eye are also being noted more frequently. Inflammation of the conjunctiva and cornea is encountered following contact with fumes from arsenic, fluorine, lead, manganese, phosgene, sulphur dioxide, zinc, etc., used in the welding industry. The commonest eye complaint is due to the continuous exposure to the electric arc, with symptoms of redness, photophobia, edema and the feeling of sand in the eyes. We have seen exaggeration of the condition by the use of buty pontocaine, etc., producing especially a d[illegible] venenata eyelids and extending onto the surrounding

Epidemic keratoconjunctivitis, a virus di[illegible] direct contact from employee to employee

GLOSSARY TOXIC HAZARDS—(Continued)

Substances	*Effect*
Sulphur dioxide	Conjunctivitis and keratitis
Sulphur dust	Irritant
Sulphuric acid	Severe irritant
Tar	Conjunctivitis, ulcers of the cornea
Terpenite	Irritant
Tergitol penetrants (manufacture of textiles)	Local irritant
Tertiary butylphenol	Irritant
Tetrahydronaphthol	Conjunctival irritation
Tetryl (particles not fumes)	Palpebritis and conjunctivitis
Thallium	Optic nerve cataract
Tobacco	Conjunctivitis, toxic amblyopia
Trichloracetic acid	Conjunctivitis
Trichlorethylene	Keratitis, amaurosis, optic atrophy
Trinitrophenol	Conjunctivitis
Trinitrotoluene	Loss of vision (central lesion)
Tungsten	Irritant
Turpentine	Irritant
Ultra-violet radiation	Irritant
Uranium	Optic nerve lesion
Vanadium	Loss of vision (central lesion) visual disturbance

Treatment.—The dermatologist should limit himself to first aid treatment by advising only boric acid compresses. If there is any involvement of the eye patients should be referred for eye consultation immediately. Prophylaxis of course is the use of properly fitted and suitable goggles in all hazardous work.

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CHAPTER XLIV

OCCUPATIONAL DISEASES OF THE NAILS

The primary function of the nails is to protect the tips of the fingers and toes from injury. Structurally, the nail is composed of closely packed keratotic cells which are believed by many authorities to contain a substance which they have named "onychin." This substance is highly resistant to many chemicals, but can be destroyed by strong acids and alkalis.

Injuries and diseases of the nails are frequently brought to the attention of the industrial physician. Trauma is the most frequent cause of onychia, although any inflammatory process of the periungual tissues such as dermatitis, tuberculosis verrucosa cutis, syphilis etc. may affect the matrix. Certain constitutional diseases may cause changes in the nails, as for example, the Hippocratic nails of patients with pulmonary tuberculosis, and Beau's lines of arthritics.

In determining the occupational origin of disorders of the nails, several pitfalls must be avoided:

1. Congenital defects, which are commonly associated with general abnormalities of the skin, hair and teeth. For example, in patients with dry, squamous, atrophic skins, the hair is scanty, dry and brittle, the teeth undeveloped and separated, and the nails thin, friable, atrophic or dystrophic.

2. Involvement of the nails by diseases which may have been contracted away from the patient's occupation, such as tuberculosis, syphilis, and mycotic infections.

3. Those cases in which an existing dermatosis not due to occupation predisposed the patient to injury from his work. This was exemplified in a case reported by *Herxheimer* and *Uhlmann*, in which a workman suffering from psoriasis developed cup-like depressions of the nails from carrying heavy loads that caused constant pressure on the matrices and free edges of the nails. After the work was stopped, the nails became normal. A similar case was observed in another patient engaged in the same work. In such cases the occupation is only a contributing cause.

Infections, chemicals, and mechanical irritation may be etiological agents in industrial affections of the nails. Continued friction from rough materials may cause wearing down or thickening. Prolonged immersion of the fingers in water may produce maceration, and infection of the nail-folds with bacteria or fungi. This condition is commonly found among bartenders, cooks, dishwashers, fishermen, washerwomen, etc.

Among paint-strippers the nails become brittle and stained; among radium workers and roentgen-ray technicians, striations, fissuring and brittleness are characteristic. Dystrophy and a pale ochre tint are seen in the nails of workers with bichromates.

Paronychia occurs among handlers of chemicals in liquid and powder form, *e. g.*, bakers, photographers, polishers, engravers, laboratory technicians, physicians, nurses, chemists, perfumers, tanners, silversmiths, dyers, etchers, automobile mechanics, etc. Lime and cement may cause an inflammation around the nail folds. Infections among wool workers are caused by the insinuation of small threads of wool under the nails.

Infections of the nails and nail folds are due usually to fungi or staphylococci which may produce lesions that are often difficult to distinguish from each other. The staphylococcus usually forms pus and inflames the folds. This form of infection occurs most often in those exposed to dusts, dirt, minor trauma and strong chemicals, as mentioned above. In onychomycosis, or fungous infection, the nails appear lusterless, vary in color from gray to yellow, brown or green, are brittle and scaly, or partly destroyed and heaped up in flakes. Yeasts and yeast-like fungi (*Monilia*) as well as dermatophytes which cause infections of the hair and glabrous skin are the etiological agents. Numerous other, usually saprophytic, fungi such as the *aspergillus*, *penicillium*, *mucor*, etc., have been reported as causative agents in some cases.

Subungual hematoma is a result of trauma and causes acute pain due to the pressure of the small blood clot under the nail-plate.

Onycholysis, a gradual separation of the nail-plate from its bed, occurs among bottle washers, dishwashers, laundresses and others whose hands are subjected to prolonged immersion in strong cleansing solutions.

The nails of workmen in many industries may be altered by reason of the materials handled or the mechanical processes used, without causing serious structural injury. The following are a few examples:

OCCUPATIONAL STIGMATA OF THE NAILS

Acetanilid produces a purple discoloration of all the nails soon after contact.

Bichromate: a pale ochre pigmentation.

Burnt sugar workers: brown discoloration.

Cigarette makers show a wearing down of the nails and thickening of the ungual phalanx from a combination of chemical and mechanical agents.

Coffee roasters: brown discoloration.

Dinitrobenzene and *Trinitrotoluene* stain the nails, as well as the hands and feet, yellow.

Dyestuffs of various kinds stain the hands and the nails according to their color; the nails become thin, atrophied and flexible.

Dyers of furs frequently suffer deformities of the nails. (See Furs.) (Fig. 112.)

Ebony workers: dark yellow or black discoloration from black dust under the nails.

Glaziers NaOH attacks the nail and retards its growth

Gunmakers discoloration from mixtures of oil, iron oxide and black gun powder beneath the nails.

Hatters black and yellow spots on the nails due to nitric acid.

Indigo Women employed in shelling indigo develop an exceptionally long right thumb nail.

Joiners discoloration of the nails due to polish.

Lace makers overdevelopment of the nail of the left index finger from pulling needles out of the cushion shortened nail of right index to avoid cutting the threads.

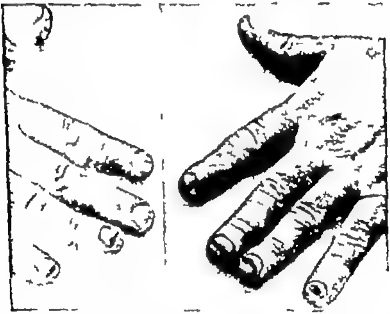

FIG. 112.—Atrophy of nails in "fur dresser" due to friction and acid in the pelts.

Mercury workers develop Beau's lines and a brown or black discoloration.

Metol brown stains on the hands and nails of photographers.

Munitions workers wear down the lateral free edges of the nails of the third and fourth fingers from friction in removing cartridge and capsule cases from the rack in which they are placed to be dipped into an acid bath.

Packers show excavation under the free border of nails of three last fingers of both hands from folding paper

Picric acid produces a light yellow staining sometimes also seen among flower handlers.

Platers corroded nails due to the action of plating solution.

Rope workers Left thumb nail thicker and larger than right, free border irregular and striated due to friction of threads.

Silver The nails of workers with this metal exhibit slate-blue discoloration due to subungual deposits of the particles. Gold and aluminum workers similarly have accumulations of these metals under the nails.

Thallium produces transverse white bands.

Washerwomen may show a crescent-shaped detachment of the nails of certain fingers (*Onycholysis partialis*)

Watchmakers exhibit a shortened and hypertrophied left thumb nail from the continual opening of watches

SECONDARY NAIL MANIFESTATIONS

Lesions of the nails associated with non-occupational dermatoses raise the problem of differential diagnosis. Blastomycosis, for example, usually involves the nails, and may or may not be of industrial origin The same may be said of eczema. The cause of psoriasis is still unknown and hence the disease cannot be attributed to occupation. For purposes of differentiation however the nail lesion of psoriasis will be described

Psoriasis.—The nails are usually involved when the lesions are extensive but in some cases the nails alone may exhibit lesions. They become dry and lusterless, with a whitish appearance resulting from minute desquamation. Masses of friable yellowish material may form beneath the nail-plate and lift it from its bed It becomes deformed and broken and may eventually drop off In moderately severe cases, the nail may be covered with small pin-point depressions, scaling at first and later becoming smooth Instead of spreading over the surface of the nail, the points may form a transverse line. In psoriasis of long standing and in arthropathic psoriasis the nails appear scaly striated worm-eaten, and lifted from their beds by subungual keratosis. They may show either atrophy or hypertrophy

Eczema.—Eczema of the hands and feet causes dystrophic changes in the nails, which are often preceded by eczematous paronychia The nails become discolored scaly and transversely striated and may split longitudinally They are brittle and break off in bits to produce a worm-eaten appearance Chronic eczema may give rise to subungual or even periungual keratoses Brief acute attacks however seldom affect the nails at the time although Beau's lines may appear afterwards, indicating that the nutrition has been disturbed In extremely acute cases there is frequently an exudative paronychia with marked inflammation and falling out of the nail-plate which grows again after the inflammation has subsided

Dermatophytids.—Dermatophytids may occur on the hands with secondary affection of the nails The inflammation affecting the nail matrix accounts for the changes in the nail-plate through interference with growth and nutrition The mechanism is the same in eczema and *other inflammatory dermatoses.*

Radiodermatitis.—Since the matrix of the nail is particularly sensitive to radioactive substances the nails are generally involved in radiodermatitis of the finger tips. The matrix undergoes atrophy resulting in nails that are thin friable, discolored and split. The nail wall and the periungual tissues may also become atrophied with thinning wrinkling discoloration and telangiectases. Acute radiodermatitis often results in loss of the nail with subsequent regrowth. In chronic radiodermatitis the nails are thin brittle and striated. There may be subungual parakeratosis, bleeding or painful ulceration. Epithelioma may develop after a number of years.

PRIMARY AFFECTIONS OF THE NAILS

The ungual and periungual tissues may be directly affected in industry by trauma, strong chemicals, fungi and bacteria.

Trauma.—Trauma may occur from cuts blows and crushing and from thorns, splinters of wood glass and other hard substances thrust under the nail. Inflammation of the matrix may result in loss of the nail which does not grow again if the matrix is permanently damaged otherwise there is usually complete restoration in about five months. In cases of chronic inflammation the nail plate becomes distorted and discolored.

Treatment is the immediate application of an antiseptic dressing to the injured nail or to the denuded area if the nail-plate has become entirely stripped off. When the nail is split in two suture of the fragments may sometimes prove successful. This method has been used by Carter and consists in boring small openings on each side and joining the fragments with 000 dermal suture. Healing and normal growth result in about six weeks.

Hematomas frequently form beneath the nails after traumatic injuries. There appears early a red stain which turns black after the blood coagulates. Pressure on the plate causes exquisite pain which can be relieved by evacuation of the clot through one or more drill holes.

Injuries of the nails and surrounding tissues frequently lead to infection by bacteria chiefly the staphylococcus and streptococcus, and occasionally the colon bacillus. Trauma from infected manicuring implements is a common source of this condition. Chronic paronychia due to staphylococcus infection is frequently seen among cooks, washerwomen bartenders, and other workers who *immerse* their hands in water for long periods. The inflammation is mild and causes little pain. *Staphylococcus pyogenes albus* is constantly found in the pus. When the condition is of long duration, the nail-plate eventually becomes deformed and discolored black or green but is seldom lost. The lesions closely resemble those caused by fungous infection, but can be differentiated by microscopic examination and cultures of the pus.

Late effects of traumatic onychia or paronychia may appear in the development of epithelioma or granuloma pyogenicum. A

case is recorded of a prickle-cell epithelioma appearing at the site of injury four years after piercing of the nail-bed by splinters of wood Granuloma pyogenicum is a small red tumor composed of granulation tissue which bleeds easily and may be pedunculated or sessile. Excision electrocoagulation or cautery are the usual methods of treatment. Good results with roentgen therapy are occasionally seen.

Heat and Cold.—Exposure to extreme cold may result in eczematous changes and striation of the nails. Burns destroy the tissue and leave deforming scars and fissures.

Hangnails.—Hangnails may result from handling chemical irritants such as strong acids, lime and cement, but may also follow the habit of biting the nails. They arise from tags of the lateral nailfold which become detached and displaced upward. The base may become excoriated, slightly inflamed and painful Although the condition is trivial it often affords a point of entrance for microorganisms which may cause a severe paronychia. The lesion is a *favorable site for the development of the primary lesion of syphilis*, especially among physicians, dentists, nurses midwives and others attending infected patients.

Early treatment consists in flattening the loose tag and sealing it with collodion. After infection has begun the tag should be excised and tincture of iodine or gentian violet applied to the base, followed by collodion. Wet dressings of boric acid or potassium permanganate should be applied if the lesion is very much inflamed

Tuberculosis.—*Verruca necrogenica* may attack the periungual tissues by direct inoculation. Physicians, orderlies, nurses, attendants in autopsy rooms, etc are prone to contract such lesions.

Pardo-Castello reported the cases of two physicians one was infected during a postmortem examination and the other after making a number of clinical examinations of a patient with a tuberculous larynx. The lesions consisted of small grayish nodules located in the lateral groove of the nail. The same author also observed a case of lupus vulgaris in an autopsy-room attendant. The terminal phalanx of the little finger was first affected and later the nail which ultimately became permanently deformed All of these cases were cured without recurrence by electrocoagulation.

Paronychia caused by direct tuberculous infection was reported by Stokes. The disease occurred on the thumb and three fingers of a young woman as the initial lesion of a generalized tuberculosis from which the patient died three years later It was dry horny translucent not ulcerated and caused the nails to become elevated and distorted

Syphilis.—The chancre of syphilis may occur in the nail-folds at a site of trauma (see Hangnails) from contact with syphilitic patients. The lesion is usually single and may begin as an indolent indurated fissure accompanied by epitrochlear adenopathy or as a hard painless nodule which grows into an exuberant mass with superficial ulceration Another form is a very painful indurated

lesion resembling a paronychia, which is secondarily infected and exudes pus. The presence of pyogenic organisms may confuse the diagnosis in such cases, but the *Spirochæta pallida* is usually present in great numbers. Painless enlargement of the epitrochlear and axillary glands confirms the diagnosis of syphilis.

The infection may occur under the nail plate at the distal end The nail becomes lusterless, dull reddish or yellowish white, friable thickened and roughened with numerous cracks and fissures. The nail-folds may become secondarily infected, with induration and scaling In some cases, pin-head sized sharply defined necrotic openings extend down to the matrix. The nail may drop off painlessly

Ringworm.—Ringworm of the nails (*Tinea unguium Onychomycosis*) like that of the hands and feet, is produced chiefly by *Trichophyton interdigitale, Epidermophyton inguinale* and *Trichophyton gypseum*. Other fungi have been implicated in some cases *e. g* *Penicillium Aspergillus* and *Scopulariopsis* The disease may affect any number of nails, from one to all The plate becomes dry lusterless and squamous, and frequently shows longitudinal striæ and a yellowish or brownish discoloration. The entire thickness of the nail may become affected, with involvement of the nail-bed and matrix. Following this, it becomes very friable and breaks off in bits, with a resulting worm-eaten appearance. Subungual débris may accumulate and raise the nail at the free edge. As the process advances towards the root, the anterior portion of the plate drops off leaving a stump near the lunula. However the entire nail is seldom lost.

Diagnosis is made by microscopic and cultural examination of scrapings from the nail According to Pardo-Castello the diagnosis should rest on the finding of mycelia rather than spores, since the latter may be easily confused with artefacts.

Ringworm of the nails occurs in the same occupations as that of the hands and feet *i. e* among employees of schools and colleges, athletic fields, public baths, swimming pools, and gymnasia.

Favus.—Favus is extremely rare in this country It is caused by the *Achorion schonleinii* and *gallinæ* which are often transmitted by mice and other animals with which workers may come in contact by reason of their occupation. The nails become yellowish thickened scaly and powdered with horny material which accumulates in great quantities beneath the nail and raises it from its bed. The nails gradually become honeycombed and eventually disintegrate.

Monilia and Yeasts.—Monilia and yeasts may attack the nails and periungual tissues, especially of women workers whose hands are immersed for long periods in water or syrups. Trauma from manicuring or injury by strong alkaline solutions often predisposes to the infection. Paronychia due to these organisms may cause secondary lesions of the nails, although in some cases they are infected independently In 12 cases of paronychia with onychia among housewives, domestic servants and dishwashers reported by Schwartz, nail infection was believed to be primary

In infections of the nail without paronychia the plate presents round or oval whitish patches which extend into the nail substance or occur on the under surface of the nail and gradually separate the plate from the bed but without destruction of the nail. Or there may be desquamation of the external surface which becomes cloudy and discolored a yellowish brownish white or greenish hue. Eventually the nail may become atrophic and be clinically identical with the lesions of ringworm.

Paronychia caused by monilia and yeasts manifests itself as a bolster-like swelling of the nail-folds with minute abscesses on the under surface of the nail wall from which beads of pus exude under pressure.

Kingery and Thienes reported a number of cases of dermatitis with severe paronychia and onychia resulting in loss of the finger nails among employees of a canning factory whose hands were continually kept in fruit juices. Unidentified yeast-like bodies were isolated from the lesions. Sutherland-Campbell observed an epidemic of onychia and paronychia among workers with orange products. A yeast of the mucor family was found to be responsible (See Mycotic Infections.) The nails showed punctiform erosions with yellowish discoloration and the adjacent skin was red and swollen.

The treatment of onychomycosis is often discouraging and of the numerous methods advocated no one appears to be entirely satisfactory. The first step is to remove as much of the infected nail as possible without inflicting further injury. This is followed by the application of some ointment containing mercuric oleate bichloride of mercury or olive oil and pyrogallol in equal parts. Roentgen-ray irradiation in fractional doses has proved effective in some cases. Pardo-Castello advocates the constant application of Whitfield's ointment which is rubbed in with a stiff brush covered with gauze and kept in place by a cotton finger-cot. The authors have found a suspension of chrysarobin 4 per cent in chloroform effective when applied to the nails around and under the folds for a period of several months. When all else fails avulsion is the final resort. Fungicides are used following this to prevent re-infection.

Sugar Onychia.—Onychia and paronychia among confectioners particularly those engaged in making candied fruits are frequently reported. The condition is described as consisting of erosions and fissures around the nail-folds followed by ulceration granulation and sero-purulent exudate. The nail often becomes loosened and sometimes drops off. After loss of the nail-plate the fingertips assume a permanent spatular deformity. The disease may become chronic with period of recession and exacerbation. Fruit acids are believed by some observers to be responsible for the affection while others incriminate the changes from hot to cold water fruit juices and syrups in which the hands are constantly immersed.

A case was reported of a woman engaged in packing cakes and biscuits. Her nails became deformed and covered with black patches.

DISEASES OF THE NAILS IN INDUSTRY

Various occupations expose the nails to special hazards, ranging from unsightly discolorations to complete destruction of the nail-plate and acute suppurative paronychia. It is necessary to distinguish between alterations in the physical character of the nails without resulting disability and those injuries in which infection, pain and destruction of tissue force the patient to stop his work. In those industries which subject the worker to undue risk, preventive measures should be instituted but where adequate protection cannot be provided susceptible individuals should be transferred to other jobs.

Following is a list of the occupations in which the nails are particularly liable to injury from disease or trauma

Alkalis.—Workers in any industry who come in contact with strong alkalis are subject to softening of the nail-plate, longitudinal striations and fissures (onychorrhexis) and hapalonychia.

Arsenic.—This substance is used in preserving skins and feathers in making insecticides in metallurgy glass making, etc. Workers in mines and chemical industries are subject to arsenic poisoning, of which transverse white bands on the finger and toe nails are considered diagnostic. Other changes are Beau's lines, melanosis, onychomadesis, and paronychia seen with dermatitis.

Automobile Cleaners.—Koilonychia due to the use of benzine

Bakers.—Paronychia from the action of flour and baking powder

Bartenders.—Onycholysis and paronychia due to water soap and fungi.

Battery Makers.—In making electric batteries, many workmen develop paronychia from contact with sulphuric acid

Bookbinders.—Paronychia from the action of paste.

Bottle Washers.—Onycholysis bacterial and mycotic paronychia.

Brewers.—Onychomycosis due to yeasts and molds, with longitudinal fissures with facets and crusty outgrowths at the root of the nail among workmen who clean the fermentation vats.

Brick-layers.—Paronychia and hangnails due to lime cement and mortar

Butchers.—Paronychia from the bristles of cattle.

Button Makers.—Paronychia and vesicles on an erythematous base from injuries by machinery and materials

Cement.—Road builders, construction workers, and others handling cement suffer from hangnails, onychomadesis, and paronychia.

Chemists.—Paronychia brittleness of nails, onychorrhexis, and discoloration from various chemicals handled. Silver nitrate produces a black pigmentation

Cigar Makers.—Onycholysis and staining due to mechanical processes and tobacco juices.

Confectioners.—Onychia, onycholysis and paronychia from sugar, fruit juices, and maceration in hot and cold liquids.

Cooks.—Paronychia from soap, water, and maceration.

Cosmetic Workers.—Irritation around the nails from hair dyes. Alum in hair tonics and deodorants, and acetone and caustic potash in liquid nail polish and cuticle remover may injure the nails of workers engaged in their manufacture and use. (See Cosmetics.)

Dishwashers.—Paronychia from maceration, soap, water, grease, bacteria, fungi.

Dye Workers.—Paronychia, onychia, pigmentation, deformities, necrosis, warty growths, subungual keratosis. Intermediates may cause inflammation and suppuration.

Engravers.—Paronychia and brittle nails, due to chemicals.

Etchers.—Discoloration, brittleness, and paronychia from chemicals.

Farm Laborers.—Onycholysis, onychomycosis, and paronychia from dirt, trauma, and fungi.

Fishermen.—Trauma and paronychia, from water, fish scales and hooks.

Formaldehyde.—After long-continued contact this chemical produces ungual lesions: softening and brown pigmentation, inflammation of the nail grooves, suppuration of the matrix and gradual decay or scaliness, friability, thickening of the plate, and non-suppurative inflammation of the matrix.

Fruit Workers.—Paronychia, onychia, onycholysis, onychomycosis among fruit canners and orange and lemon peelers, due to the action of juices and to fungous infections.

Galvanizers.—Dark blue pigmentation of distal end of nail and ulceration of the volar aspect of fingertip from silver and cyanide solutions.

Gardeners.—Onychomycosis, onycholysis, and paronychia from dirt, trauma, and fungi.

Glass Workers.—Koilonychia, brittle nails, and paronychia due to mechanical agents and acids.

Grocers.—Paronychia from handling sugar and flour.

Hatters.—Paronychia in felt-hat plankers and sizers. Yellow and black spots on nails from nitric acid; dystrophy of nails due to sulphuric acid and mechanical action of the hair.

Hospital Attendants.—Chancre of the nails and periungual tissues; verruca necrogenica, due to infection.

Laboratory Workers.—Brittleness and onychorrhexis due to contact with formalin, acids, and alkalis.

Laborers.—Onychia and paronychia from trauma and dirt.

Lead Workers.—In industries where lead is used, poisoning from this substance may produce lancinating pain in the nails, white spots, and onychomadesis without normal regeneration.

Lime Chloride of.—Erosion of the nails destruction of the free border

Mechanics.—Onychia and paronychia from trauma and oils.

Mercury.—Dryness, friability, Beau's lines, brown or black discoloration either directly by handling the substance or secondarily from systemic mercurial poisoning

Milkers.—Onycholysis, cowpox, hyperkeratosis, and partial destruction of the nails due to cow bristles under the nail and infection.

Miners.—Transverse striations and onychomadesis, secondary to carbon monoxide poisoning

Nurses.—Paronychia, discoloration, onychorrhexis, and chancre, from chemicals, disinfectants, and contagion.

Oxalic Acid.—Workmen engaged in bleaching mahogany and walnut with oxalic acid solution may suffer inflammation at the roots of the nails, with redness and swelling of the fingertips.

Painters.—Injuries from lead poisoning (see Lead) paronychia, and brittleness of nails from paints, dyes, and turpentine. Paint strippers suffer from brittleness and black pigmentation of the nails

Pastry Cooks.—Paronychia due to flour sugar and fruit juices.

Peroxide.—Workers handling peroxide of hydrogen suffer destruction and shedding of the nails.

Photographers.—Paronychia and discoloration and brittleness of the nails from chemicals. Silver nitrate produces a black pigmentation.

Physicians.—Paronychia, discoloration, onychorrhexis chancre, and verruca necrogenica, due to chemicals, disinfectants, and contagion.

Pianists.—Atrophy and loosening of the nails of left little finger and right thumb from friction with the piano keys.

Polishers.—Brittle nails from contact with aldehydes and phenols.

Porters.—Deformities and traumatic lesions.

Radium Technicians.—Atrophy radiodermatitis, white bands on the nails due to the action of radium.

Roentgenologists.—Thinning and friability of the nails, and radiodermatitis.

Shoemakers.—Paronychia from leather polish.

Silversmiths.—Slate-blue deposits in the nail-bed symptomatic of argyria paronychia and brittle nails from chemicals.

Straw Plaiters.—Onychomycosis.

Tanners.—Paronychia from tannin, sodium proto-sulphide, lime, chrome salts, and bacterial infections.

Textile Workers.—Paronychia and necrosis of nails from friction with threads. Onychia of great toe nails among barefoot workers in cotton mills due to damp and greasy floors.

Tulip Bulb Handlers.—Packers and sorters develop peri-onychial and hyponychial lesions of the finger-nails from the action of the juice (see Plants and Woods)

Vegetable Cleaners.—Dystrophy, atrophy, suppuration of the nails and surrounding tissues and onycholysis from dirt and infection.

Violinists.—Violinists, harpists, and other players of stringed instruments develop callosities which often become inflamed and suppurate. There is also swelling and pain particularly in the left thumb and index finger. The index finger frequently shows small epidermal hemorrhages. The skin around the nail is affected in some degree.

Washerwomen.—Paronychia and onycholysis from soap, water, lime, and starch.

Wool Workers.—Paronychia from wool threads under the nails.

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CHAPTER XLV

ANALYSIS OF SKIN HAZARDS IN ONE HUNDRED AND FOURTEEN OCCUPATIONS

In this section we have endeavored to set forth the chief risks to which workers are exposed in their various occupations. We have been hampered to some extent by the secrecy in which many manufacturers shroud their formulæ and processes but in most industries, when the substances are known the hazards are obvious. We have also been aided by our own case histories and the numerous reports of our colleagues.

ABRASIVE WHEEL OPERATORS

Abrasive wheel operators sometimes develop dermatitis from the sharp pieces of abrasive material (carborundum) which is thrown off the wheel against the skin. Some workers become sensitized to the resin glues which are used to stick the abrasive to the paper which fits around the wheel Abrasive wheel operators should wear goggles and sleeves.

ADHESIVES

This subject embraces a wide range of substances from which are manufactured glues, cements and pastes for innumerable industrial purposes. Most of the materials together with their solvents are capable of causing dermatitis both among workers engaged in their manufacture and among those who use them in the manufacture of other articles such as machinery implements, paper boxes, toys novelties and jewelry in brick and tile construction, cabinet-making plumbing as well as for repair work of various kinds

Cements.—These fall into two categories (1) Cements used as adhesives for fixing one substance to another and (2) cements used as fillers such as putty dental fillings etc. It is with the first group only that we are here concerned the second will be treated in a separate section

Portland cement and similar cements, used in the building trade for reinforced concrete, mortar plaster etc. consist of lime, clay and silica in varying proportions. They produce dermatitis known as "cement itch" which is described in the chapter on alkalis

Portland cement and lime enter also into adhesive mixtures for fixing glass to iron celluloid to wood tin etc. for uniting glass, stoneware and metal and for a number of other purposes.

Lead and its compounds are other dangerous ingredients used in various cements. Caustic soda asphalt pitch rosin copal, formaldehyde turpentine benzine benzol shellac borax Burgundy pitch (a resin) rubber carbon bisulphide, potassium bichromate

paraffin various waxes, and certain essential oils are also irritants present in many cements.

The cements and other adhesive compounds and mixtures employed in industry are so numerous that we can give no more than a brief list and suggest their general characteristics.

For cementing sections of stone or marble slaked lime, chalk and kaolin are mixed and stirred with an equal quantity of potash water glass. Other mixtures for the same purpose consist of the following hot plaster of Paris sifted onto a layer of thin glue and spread over the warmed surfaces to be joined 10 parts of iron filings 2 parts of ammonium hydrochlorate, and 1 part flour of sulphur pulverized together after which 20 parts of iron filings are added and the whole made into a paste with water For mending small articles of marble or alabaster, curds are made by mixing equal quantities of vinegar and milk to which are added enough white of eggs and quicklime to make a paste.

For joining sections of sandstone, melted sulphur and rosin are mixed and litharge and ground glass added or 1 part of wax to 10 parts of pitch are melted together and mixed with brickdust. Before the cement is applied the surfaces are painted with one or two coats of oil varnish.

To fasten brass to glass, caustic soda, rosin, and gypsum are finely powdered and boiled together with 5 parts of water

Horn and glass can be firmly united by a solution of gelatin in water to which mastic dissolved in spirit is added and zinc white stirred in.

Several formulas are employed for cements to attach glass to iron 5 parts of rosin to 1 part of yellow wax melted together and 1 part of Venetian red added to the hot mixture 1 part each of prepared chalk and fine sand to 2 parts of Portland cement made into a paste with a solution of sodium silicate a paste made with 3 parts of boiled linseed oil 1 part of copal varnish 1 part of white lead, and 2 parts of litharge.

In the cutlery trade, knife blades are fixed into their handles by such cements as pitch mixed with a little wood ashes and tallow caustic soda and rosin boiled in water and mixed with plaster of Paris, gutta percha and shellac melted together and applied while hot to the articles which are heated to the same temperature a paste of litharge and glycerine rosin sulphur and iron filings heated together

In the repairing of articles made of celluloid or manufacture of such articles when it is necessary to join parts of the material together an adhesive made of camphor dissolved in alcohol and mixed with an equal weight of shellac is used A sort of autogenous welding also can be done by applying a mixture of 3 parts of alcohol and 4 parts of ether to the fragments to soften the edges so that they can be united by pressing together To affix celluloid to wood tin etc. 2 parts of shellac, 3 parts of spirits of camphor and 4 parts of strong alcohol are used.

Although hard rubber cannot be mended to yield a firm joint the following is employed where no great strain is expected equal parts of gutta percha and real asphaltum melted together and applied hot to the broken surfaces.

Various mixtures are used for sign letters. They consist of copal varnish turpentine, and oil melted and mixed with slaked lime or white lead litharge linseed oil and copal varnish made into a firm dough In some cases white lead litharge, and oil are mixed with mastic, melted and applied hot, thus subjecting the workers to the noxious fumes of lead as well as the mastic. In certain mixtures glue is used with varnish and turpentine, all three being skin irritants.

Enamel letters are attached to glass by a mixture of white lead and oil made into a putty with copal varnish.

Cement for porcelain letters is made with caoutchouc and linseed oil varnish boiled together during which process slaked lime is gradually poured in The mixture is often thinned with oil of turpentine.

For porcelain glass, and metals other than copper and its alloys, a strong cement is used which consists of 1 part powdered shellac to 10 parts of ammonia water

Asphalt dissolved in benzol is used to unite glass for photographic purposes, for microscopes, etc. Other glass cements consist of casein dissolved in a concentrated solution of borax or of casein and water made into a paste.

Jeweler s cements are composed of mastic dissolved in rectified spirit of wine and benzine and mixed with isinglass. For enameled watch dials, dammar and copal resin are mixed with Venetian turpentine and spirit of wine with the addition of zinc white and a little Berlin blue melted together For various metals, a paste of casein, slaked lime, sand and water is employed. Amber may be repaired by moistening the fragments with caustic potash and pressing them together when warm Another amber cement consists of finely powdered copal dissolved in pure sulphuric ether Shellac, glue mastic, and gum ammoniac are ingredients of other cements used for jewelry

Rubber may be cemented with gutta percha and genuine asphalt melted together and applied hot. In the manufacture of machinery rubber bands are affixed to iron band-saw wheels with powdered shellac which has been steeped for several weeks in strong ammonia water

To unite rubber and leather a diluted solution of gutta percha in carbon bisulphide is applied to both materials which have previously been abraded. After the solution has soaked in, a thin film of gutta percha is pressed onto each surface of the joint between heated rollers.

Rubber and wood may be united by macerating pure gum rubbers in naptha or gasoline letting it stand for two weeks, and applying to both materials. Other effective cements for this purpose consist

of shellac dissolved in strong ammonia gutta percha dissolved in oil of turpentine and carbon bisulphide or gum rubber dissolved in carbon bisulphide to which rosin and gum lac are added Cements made with carbon bisulphide must be used with caution because of its extreme volatility and inflammability

Cements for patching rubber tires may consist of India rubber chloroform benzol and mastic or gutta percha carbon bisulphide and Eau de Cologne. Pneumatic tires may be fixed to bicycle wheels with a cement of shellac gutta percha, sulphur and red lead asphalt is sometimes substituted for the shellac.

Some leather cements are composed of similar ingredients, e g., gutta percha Syrian asphalt carbon bisulphide, and oil of turpentine. Others contain irritants such as tannin mastic and glue

The so-called aquarium cements for joining glass to iron generally consist of litharge sand plaster of Paris and powdered linseed oil with a suitable drier or powdered graphite slaked lime barium sulphate and linseed oil varnish

Pastes.—These are generally more innocuous than glues or cements. They consist largely of flour or starch boiled in water Some pastes, however contain small proportions of such chemical as alum borax glue nitric boric acetic or salicylic acid phenol resins turpentine plaster of Paris, acacia and essential oils.

A paste that is said not to mold is made of flour boiled in water to which is added light brown sugar and a small amount of mercuric chloride dissolved in hot water

Mucilages.—Mucilage is composed of gelatine or gums such as gum arabic tragacanth acacia starch dextrine elm salep or sassafras-pith thinned with water That used by the United States Government for postage stamps consists of 1 part gum arabic 1 part starch and 4 parts water boiled together

Some formulas also call for glycerine acacia thymol and oil of cloves or lavender A mucilage for affixing wood or pasteboard to metal contains a large proportion of lead acetate with alum gum arabic and flour

Waterproof and Heat Resisting Adhesives.—For certain purposes cements must be able to resist heat moisture and the action of chemical This is particularly the case with lutes used for sealing joint vessels tubes, retorts etc Lutes always consist of a menstruum containing dissolved or suspended solids impervious to liquids and gases. They are applied in water or a volatile solvent which is allowed to evaporate The substances used are plaster of Paris hydraulic cement clay lime asphalt pitch rosin, rubber linseed oil casein albumen sodium silicate oxychloride cements, flour starch etc Plaster of Paris is often combined with asbestos straw plush trimmings hair or broken stone for this purpose

Waterproof adhesives applicable to glass stoneware and metal are made of whiting plaster of Paris, litharge and rosin mixed to a paste with copal varnish or a paste of boiled oil brick dust and slaked lime A Chinese glue which is impermeable consists of

shellac dissolved in ten times its weight of ammonia. A glue impervious to boiling water is one dissolved in nearly its own weight of bichromate and about a tenth part of alum.

A cement which is resistant to water heat, and petroleum for attaching copper to glass is made of caustic soda, colophony and plaster of Paris. In this preparation zinc white, white lead, or slaked lime may be used instead of plaster of Paris.

An insoluble cement is made of a fairly strong glue or gelatin solution mixed with a small amount of concentrated solution of potassium dichromate

Waterproof cement for pasteboard and paper is prepared with pure glue swollen by soaking in cold water The excess water is removed and the glue melted over a water bath The substance is spread on the paper and before drying is treated with formaldehyde. Another waterproofing mixture for this purpose consists of pitch and gutta percha melted together boiled linseed oil and a small quantity of litharge are added and the cement diluted while warm with benzine or oil of turpentine.

A waterproof cement for leather is made with gutta percha caoutchouc, benzoin gum lac, or mastic dissolved in carbon bisulphide chloroform ether or alcohol

Impermeable cement for glass is composed of white glue and potassium bichromate dissolved in water A glass cement that resists both heat and water is made with silver litharge white lead boiled linseed oil and copal varnish thoroughly mixed

A Chinese cement known as "Shio Liao" is used for gypsum marble porcelain stone, and stoneware. It is composed of slaked lime 54 parts, powdered alum 6 parts, and fresh strained blood 40 parts. This is used in the form of paste as a cement, or in liquid form as a waterproof paint.

Waterproof and acid proof pastes are made with chromic acid, ammonia, sulphuric acid cuprammonium and fine paper

A glue for wood paper and cloth is made with strong glue soaked for twelve hours in cold water It is then dissolved in a glue pot and one-half the quantity of gelatin which has been soaked in water for two hours is added. When this mixture is thoroughly dissolved bichromate of potassium or chrome alum dissolved in boiling water is stirred in. This makes a very strong cement and after it has been applied to the materials and has thoroughly dried, it can be made waterproof by one hour s exposure to strong sunlight.

AGRICULTURAL LABORERS AND MARKET GARDENERS

(See also Florists)

The work of farm laborers often includes felling trees, sawing wood the care of animals, milking sheep shearing etc. in addition to tilling the soil and planting and harvesting crops. Thus, these workmen are exposed to affections of the skin from a wide variety of sources poisonous plants and woods, bacteria and parasites in

the soil fungi chemical poisons in fertilizers and insecticides, diseased animals, noxious insects, acari the extremes of heat and cold and the actinic rays of the sun. Vegetable and fruit gardeners are subject to similar hazards, with the exception of those due to contact with animals

In both occupations *traumatic injuries* such as cuts, pricks, bruises and abrasions are frequent and add measurably to the risk of infection Pyogenic infections are common

Poisonous plants and woods produce symptoms ranging from localized dermatitis venenata to extensive eruptions with constitutional symptoms. Individual sensitivity and in some cases photosensitivity are underlying factors. Poison ivy and varieties of sumac are the commonest sources of irritation but numerous other plants, weeds, vegetables, fruits, grain shrubs and trees are capable of producing dermatitis. These are listed and described in Chapter XXXVIII on Plants and Woods (*q v*)

Acari such as *Pediculoides ventricosus* are transmitted by vegetation chiefly grain and straw and produce a severe itching dermatitis commonly known as grain itch Trombidiosis, or harvest itch results from infestation with chiggers which live on grass, low bushes, weeds and shrubbery Gooseberries and rotting bulbs such as onions are carriers of acari. Gamasoidosis, or fowl mite disease, may be contracted from poultry and scabies from animals infested with *Acarus scabiei*. (See chapter on Insects and Animal Parasites.)

Domestic animals and poultry may transmit a variety of infectious diseases

- Anthrax—from horses, sheep goats pigs, etc.
- Glanders—from horses.
- Foot-and-mouth disease—stomatitis from cattle, hogs and sheep
- Noma—stomatitis from calves.
- Contagious pustular stomatitis—from horses
- Dermatitis contagiosa pustulosa canadensis—from horses.
- Brucella eruption—from cows and pigs.
- Botryomycosis—from horses cattle and pigs.
- Trichorrhexis nodosus—from the hairs of horses and cattle
- Avian and bovine tuberculosis.
- Rat bite fever—from bites of rats, ferrets pigs, etc.
- Milker's warts—from the udders of diseased cows.
- (See chapters on Bacterial Infections and Diseases of the Mouth)

Insects may cause dermatitis and systemic diseases by their poisonous secretions by implantation of bacteria beneath the skin or by bites that become secondarily infected. The hairs of moths and caterpillars may penetrate the skin and carry with them toxins that produce a pruritic dermatitis and a nodular ophthalmia. Rocky Mountain spotted fever may be transmitted by ticks tularemia by ticks and flies and malaria and other fevers by mosquitoes. The

bites of bees, beetles, leeches wasps, spiders, ants, gnats, and reptiles frequently cause severe dermatoses. Hookworm is contracted from soil infested with larvæ of Ankylostoma which penetrate the skin of the feet. (See chapter on Insects and Animal Parasites.)

Fungous infections such as blastomycosis sporotrichosis, and actinomycosis may be contracted from vegetation or animals, especially in the presence of trauma, and trichophytosis from horses, cattle, sheep cats, dogs, pigeons, and poultry. (See chapter on Mycotic Infections.)

Manure.—A disease resembling malignant pustule may arise from handling manure containing the septic vibrio. The eyes are chiefly affected the lids swell and develop phlyctenular ulcers that rapidly become gangrenous. There is edema of the face, chest, and neck accompanied by high fever which subsides in about five days. The necrotic tissues slough off and leave the eyelids deformed. The disease appears most frequently in warm climates. Prophylaxis should be observed by the use of masks and goggles which cover the brows and cheek bones, by protection against flies, frequent cleansing of the face and abstention from scratching or rubbing the eyes with soiled hands. The scattering of manure by hand should be avoided.

Trench foot may be incurred from manure containing *Scopulariopsis koningii*, and erysipeloid from the excrement of infected animals. *Clostridium tetani* is found in soil and manure and gains entry through a break in the skin. Fatal cases of tetanus have been reported in this occupation. (See Florists.)

Artificial fertilizers such as guano and Poudrette are composed of animal vegetable and mineral matter obtained from excrement débris, etc. or are chemically manufactured. Their nutrient ingredients are nitrogen compounds phosphoric acid and salts of potassium Thomas slag or basic slag is a fine powder containing a high percentage of phosphoric acid and quicklime. Inhalation of the dust may produce respiratory disease and accumulations on the skin cause dermatitis through chemical and mechanical irritation. The cutaneous reaction of agricultural workers who scatter the fertilizer by hand is similar to "cement worker's itch" (*q. v.*) Actual burns have also been reported from this source.

Insecticides are generally composed of chemicals, all of which are irritating to the skin and may cause severe dermatitis. (See Insecticides.)

Heat Cold and Light.—Exposure to extremes of temperature subjects agricultural laborers to chilblains, frost-bite, prickly heat, intertrigo etc. Excessive sunlight may cause sunburn urticaria hydroa-æstivale lupus erythematosus, exacerbation or recurrence of pellagra and epithelioma in some persons after many years of exposure Lightning stroke to which outdoor workers are especially liable is not necessarily fatal but often results in severe burns of the skin (See chapter on Physical and Mechanical Agents.)

AIRPLANE MANUFACTURE

This report is based on studies made in nine airplane factories located in various parts of the United States, employing over 100 000 workers, and making various types of aircraft—training planes, commercial planes, and all types of fighting planes and bombers. Four of these plants had reported 117 cases of dermatitis to the Compensation Commission during the preceding fifteen months. Records were not available from the other five plants. Thirty-six active cases of dermatitis were seen during the course of our inspection 24 of which were definitely of occupational origin.

The three principal parts of an airplane (1) the motor (2) fuselage wings and controls and (3) the flying instruments, are made in different factories but are all assembled into the complete machine at the factory where the fuselage wings, and controls are built, and where our studies were made.

Process.—The airplane consists essentially of a chassis or framework of stainless steel metal tubing the parts welded together somewhat as the framework of a bicycle Around this framework is built the fuselage and to the fuselage are attached the wings, the controls and the motor

The fuselage is made of sheets of duraluminum alloy called "dural The sheets of metal are molded into proper shape by presses or by hand and the parts are riveted or welded together In most of the larger planes the wings tail and controls are also made of aluminum alloy the composition of which may vary somewhat according to the part of the plane into which it goes. In most small planes, and some larger ones, the wings and controls consist of a framework of metal over which is drawn a fabric covering made impervious by the application of dope Dope consists essentially of cellulose acetate or nitrate dissolved in a solvent such as acetone amyl acetate etc.

Other alloys of aluminum such as Alclad and Dow Metal are used in various parts of the plane.

The rivets, screws, nuts and bolts which are used where welding cannot be done are made of iron or steel made rustproof by cadmium plating or by anodizing

The various parts of the plane when completed are assembled on the assembling line in a manner similar to that of an automobile but the line moves very much more slowly

Dural an alloy consisting of aluminum copper magnesium manganese and iron Alclad containing the same materials but in different proportions, and Dow Metal an alloy of magnesium manganese silica, and aluminum come into the factory in large sheets, several sheets being crated together in wooden crates for shipment Some of the sheets are heavily coated with an oil called fish oil the composition of which is said to consist of 96 per cent highly refined Mid-Continent Neutral Oils to which is added a 4 per cent

winter pressed fish oil.[1] In one large factory many workers exposed to this oil developed a hypersensitivity to it as shown by patch tests, and dermatitis of the forearms, face, and other exposed parts ensued.[2] None of the workers uncrating the metal from the wooden crates were affected perhaps because they all wore gloves and coveralls, primarily as protection against cuts while lifting the thin, sharp-edged sheets, but which evidently also served to prevent contact of the skin with the oil. Workers who handled cut sheets before the oil was washed off did not wear such protective clothing and they were more or less constantly in contact with the oil. It was in this group of workers that dermatitis caused by "fish oil" was observed.

We have had reports of dermatitis occurring among workers in a motor manufacturing plant exposed to an oil sprayed on metal parts to prevent corrosion. This oil also has a fishy odor and was thought to be "fish oil" but inquiry from the manufacturer revealed that it consisted of fatty oils derived from rapeseed, lard, and rice bran plus butyl alcohol and about 3 per cent of a tertiary phenolic amine, a condensation product of dimethylamine with phenol in the presence of formaldehyde. This tertiary phenolic amine is said to neutralize free acid, thus preventing rancidity of the fatty oils and also preventing corroding of the metal. The tertiary amine has the fishy odor characteristic of the methylamines, and this may lead one to think that there is fish oil in the compound. The tertiary phenolic amine is also an irritant and sensitizer if allowed to remain on the skin for a considerable length of time. This, or another inhibitor or non-corrosive with similar action that may be in the winter pressed fish oil, is more likely to be the actual cause of the dermatitis occurring among the workers exposed to the so-called fish oil on the dural sheets than any animal, vegetable, or fish oil which it may actually contain, as such oils are usually harmless.[3]

In some factories the dural sheets when received were covered with a coat of varnish which was applied to them by the makers in order to protect them from scratches and cuts in shipping and handling. Some workers were found who had dermatitis caused by sensitivity to this varnish. Sheets of uncoated dural were also received in these factories and in some places the sheets, after being uncrated, were dipped into a tank containing a preparation called "line oil" in order to protect the surface from scratches in the process of manufacture. "Line oil" consists of soybean oil and spent varnish containing various resins dissolved in Stoddard solvent (a petroleum distillate). The sheets, after being dipped into the tank of "line oil," are lifted out, allowed to drip and dry, leaving a dry surface coating consisting of the oil and resin. The workers at this job had their arms, hands, and clothes soiled with the "line oil" and a number of cases of dermatitis have resulted. This dermatitis may

[1] An oil of animal or vegetable origin is added to the petroleum oil in order to make it adhere to the metal.

[2] Lounsberry, C. Ray: Occupational Dermatoses in the Aircraft Industry, Calif. and West. Med., 51, 309–312, 1939.

[3] The makers deny the presence of an inhibitor in this oil.

be due to the defatting of the skin by the Stoddard solvent or it may be caused by the development of allergy to the resins or the soybean oil. There were no cases of dermatitis found in any of the factories that could be attributed to the uncoated aluminum or magnesium alloys. Therefore it is believed that the so-called "dural poisoning" in airplane factories is not caused by the alloy itself but by the oils, varnishes, and paints which are applied to its surface.

Dermatitis among this group of workers can be prevented by having all sheets of oiled or varnished alloy which come into the factory washed clean of coating before permitting them to be handled by the workers. The men employed at cleaning the coating from the sheets should wear protective clothing such as rubber boots and gloves, aprons, and sleeves made of impervious material such as the synthetic resins, pliofilm, koroseal, vinylite, etc. Men exposed to "line oil" should be similarly protected.

Since there is no particular starting point in airplane manufacture the various processes in which skin hazards occur will be described in alphabetical order.

Anodizing Department.—Anodizing imparts to the metal a dull gray finish which is rustproof and tarnishproof. Before anodizing all dirt, grease, and scale must be removed from the surface of the metal. This is done by immersing in acids and solvents and washing in a hot alkali solution, then in water, then again in a solution of soap (Kelite), again rinsing in water, and then immersing in the anodizing tank. The anodizing tank contains a solution of chromic acid and dichromates. Although most of the dipping of the metal parts into the various solutions is done by mechanical means and the anodizing tank is vented and usually kept closed when not in use, splashes from the tanks containing the cleaning solutions and fumes of chromic acid and dichromates from the anodizing tank may affect the worker, causing dermatitis on the intact skin, and ulcers if the irritant liquid enters abrasions.

In some factories this department also contains tanks of nitric acid and hydrofluoric acid into which the metal is dipped. Dermatitis may occur from splashes and fumes of both these powerful acids.

Various coal tar and petroleum distillates as well as trichlorethylene are used in this department for degreasing metals and for removing paint from them before they are anodized. Dermatitis has occurred from exposure to these degreasers which are fat solvents and sensitizers. When the wet metal is lifted out of the anodizing tank and hung up to dry, workers handling it may develop ulcers and dermatitis from the chromic acid solution remaining on the metal as well as from the fine gray dust which coats the parts after they are dry. In addition to proper local exhaust ventilation over these tanks[1,2,3] the workers in this department should be furnished with long

[1] Bloomfield, J. J., and Blum, W.: Health Hazard in Chromium Plating. Pub. Health Rep. 43, 2330, 1928. Reprint No. 1245.

[2] Riley, E. C., and Goldman, F. H.: Control of Chromic Acid Mist from Plating Tanks. Pub. Health Rep. 52, 172, 1937. Reprint No. 1801.

[3] Bloomfield, J. J.: Poisoning by Chromium Compounds. Safety Eng., 61, 224, 1931.

rubber gauntlets over which they should wear sleeves of impervious material buttoned at the wrist. Aprons of a similar material would prevent the soiling of the clothes and dermatitis of the covered parts. Workers exposed to the fumes issuing from chromic acid and hydrofluoric acid tanks should insert vaseline into the nostrils several times a day in order to protect the nasal mucosa from the corrosive effect of these chemicals.

Because the various solvents used in this department act to defat the skin and thus cause drying, chapping, and chronic eczema, it is recommended that no strong soaps, bleaches, or solvents be used by the workers for cleaning the skin after work. A neutral sulfonated castor oil containing 2 per cent of a wetting agent (such as Duponol, Aerosol Santomerse Naconol or Igepon) should be provided for the workers, instead of soap for cleansing the hands after work. Such a mixture, because of its vegetable oil content will not defat the skin and yet will clean it. Workers with dry chapped skins should also rub into the skin before and after work a mixture of an hydrous lanolin and olive oil. This will act to buffer the action of the fat solvents on the skin and will tend to replace whatever fats such solvents may remove from the skin.

Degreasing.—Degreasing tanks are usually located in the anodizing and cadmium plating departments. Some of them are large rectangular tanks with the surface of the solvent, usually trichlorethylene, about three feet below the top of the tank. A few inches above the level of the liquid and running around the inside of the tank, there are cooling coils for the purpose of preventing the evaporation and escape of fumes. Some degreasing tanks are simple covered containers with no other safety appliances. Workers dipping metal parts into the tanks are exposed to the fumes and vapors which may escape and to splashes when the metal parts enter the liquid, and drippings of the solvent as the metals are taken out. Trichlorethylene is a fat solvent and can cause a chronic dry cracked fissured eczema of the hands and arms. It is also a sensitizer and can cause a more or less generalized acute eczematoid type of dermatitis which begins as an erythema becomes papular then vesicular and is followed by oozing, crusting and desquamation.

All degreasing tanks should be so constructed that fumes cannot escape.[2] The workers should be protected against splashes and dripping by protective clothing. Rubber and the ordinary impervious films are attacked by trichlorethylene and carbon tetrachloride the chemicals usually used for degreasing but the polyvinyl alcohols are not. Aprons, sleeves and gloves made of the polyvinyl alcohols can be obtained and should be used by workers on degreasing operations where the chlorinated hydrocarbons are used as degreasing solutions.[3]

Witheridge, W. N., and Walworth, H. T.: Ventilation of Trichlorethylene Degreaser. Jour. Ind. Hyg. and Toxicol., 22, 175-187, May 1940.

Resistoflex is the trade name of a polyvinyl alcohol which will resist the action of the chlorinated hydrocarbons, but it will not resist the action of water and steam.

To counteract the defatting action on the skin of these solvents a skin cleanser and protective ointment should be used similar to that described under anodizing

"Dope" Room.—Here the fabric parts of the plane (wings and controls) are fitted over the metal framework and made impervious by the application of the so-called dopes. The dopes are applied by hand brushes. They consist essentially of a solution of cellulose nitrate or acetate in a volatile solvent such as acetone amyl acetate etc., which after evaporating leaves the fabric impregnated and coated with the cellulose compound making it impervious. On entering this room the strong odor of solvents first irritates the nose throat and eyes, causing coughing and lacrimation but after a few minutes these symptoms cease probably because of the anesthetic action of these esters on the mucous membranes Most of the dope rooms have exhaust ventilation of some kind but in spite of this the dope" permeates the air

The dopes" have a defatting action on the skin and can cause dry chapped hands and chronic, fissured eczemas of the hands and arms. A small percentage of workers become sensitized and develop acute eczematoid types of dermatitis of the hands, arms, face, and whatever other parts may be exposed to the solvents or their fumes.

Workers exposed to dopes' should wear fabric-lined rubber gloves over which sleeves made of impervious fabrics should fasten at the wrist Long aprons of the same materials will protect the clothes from being soiled. Workers who are hypersensitive should apply to the face neck, and other exposed parts the protective ointment of lanolin and olive oil described above. Those workers with dry and defatted skin should use the mixture of sulphonated castor oil and wetting agent described above for a hand cleanser instead of the usual soaps or volatile solvents.

It was observed that some of the girls employed at sewing the fabric coverings of the wings and controls of airplanes developed blisters and irritation of the fingers from the long sharp needles which they used Many of them wore leather finger shields for protection Such shields should be furnished to all engaged in this occupation

Drop Hammer Department.—Many of the metal sheets are shaped to the desired form by placing them on molds and allowing hammers, the faces of which fit into the molds to fall on them The hammers are raised by hand ropes, and dermatitis of the hands has occurred from the mechanical action of friction in handling the ropes as well as from the oil and resin with which some of the ropes are treated in order to make them strong and serviceable. Petroleum oils and grease are used on the dies and metal plates in order to protect the metal and the clothes often become soiled with oil and grease resulting in folliculitis of the thighs and forearms especially among workers who do not frequently change to clean clothes or who neglect cleaning their skin after work To prevent these conditions,

workers at the drop hammers should wear leather or canvas gloves and impervious sleeves and aprons.

The same hazards are present in the hydraulic press department where larger pieces of metal are molded in similar manner by hydraulic presses.

Gas Tanks.—Gas tanks are made of molded dural plates welded together. The complete tanks are dipped in a vat containing a solution of potassium dichromate and nitric acid resulting in a grayish-green color on the surface of the tank which prevents rusting. The vat containing the potassium dichromate and nitric acid is an open one and workers should be protected against splashes and fumes by rubber gloves, impervious sleeves, and aprons, and by placing vaseline in the nostrils as described under anodizing.

A sealing compound is applied to the surface of the gas tank. This compound consists of zinc chromate, asbestos mica, a synthetic resin and a drying oil in a thinner such as ethyl acetate. Dermatitis may result among workers applying this sealing compound to the gas tanks. The solvent may cause dermatitis either by its fat solvent action or by its sensitizing action and skin sensitivity to zinc chromate and synthetic resins has also been observed among these workers. Workers engaged in applying this paint to the gas tanks should wear the protective clothing described above under the discussion of the hazards in the "dope" room.

Gas tanks are enclosed in a covering of a rubber-like compound which is said to plug up bullet holes. The composition of this substance was not learned, but it is soft and doughy resembling unvulcanized synthetic rubber. No cases of dermatitis were noted from handling this substance. A leather casing encloses the gas tank and its covering.

Heat Treatment.—Heat treatment increases the strength of the metal parts. Some of the parts are dipped in a tank containing molten sodium nitrite to which a small percentage of sodium dichromate has been added. The tank is covered with a lid, but when the lid is lifted fumes of nitrous and chrome compounds are given off and may irritate the nose of workers standing over the tank. Therefore, in addition to exhaust vents over the lid workers around this tank should insert vaseline into the nostrils to prevent nasal mucitis. Gloves are indispensable because of handling hot metal but impervious sleeves and aprons should also be worn because the fumes may irritate the skin, causing dermatitis and ulcers.

Some of the metal is treated by immersion in molten sodium cyanide. The vessels containing the molten sodium cyanide usually have over them exhaust vents to prevent the fumes of hydrocyanic acid from coming in contact with the workers. Nevertheless, vaseline in the nostrils insures the protection of the nasal septum from whatever cyanide fumes faulty vents may allow to escape. Gloves and impervious sleeves and aprons should be worn to protect the skin from the corrosive action of cyanide.

Hydrofluoric Acid.—Tanks containing hydrofluoric acid are located in some of the departments. Into them are dipped metal parts for etching, and also for coating with fluoride so that they be "spot welded." Burns of the skin and ulceration of the nasal septum are hazards to workers dipping metal into these tanks.[1] Tanks of hydrofluoric acid should be kept covered and vented so that the workers are not exposed to fumes and splashes of this corrosive liquid. The workers should insert vaseline into the nostrils several times a day to prevent nasal mucitis, and should wear sleeves, aprons, and gloves of impervious material.

Machine Shop.—The metal parts are cut and drilled in the machine shop. The lathes and other machines are lubricated by oils both soluble and insoluble. The soluble oils consist chiefly of sulphonated mineral oils which are miscible with water, forming a milky emulsion, and are used mainly to cool the cutting tools, although they also facilitate the actual cutting operation. The chief function of the insoluble oils is to make cutting easier and to save the cutting edges of the lathes, drills, etc., but the insoluble oils also act as cooling agents. The insoluble oils are composed of mixtures of mineral oils to which are added animal and vegetable oils, as for instance, the so-called lard oil which consists of a mixture of mineral oil and lard oil. When animal and vegetable oils are contained in cutting oils, the manufacturers of the oils usually add a small amount of preservative in order to prevent the oil from becoming rancid. Such preservative must be antacid and non-corrosive. The oils circulate in the machines, being filtered in the course of circulation in order to screen out metal chips and dirt. In some factories the oil in the machines is changed once a week, the used oil being thrown away. In other factories the change is made at irregular intervals whenever the worker thinks it should be, and the used oil may be reclaimed or thrown away. In still other factories, the oil is rarely changed, additional antiseptic being added to it from time to time as it becomes rancid. In the latter case, oil has at times been found to contain as high as 10 per cent of the phenolic compound usually used as an antiseptic.

When used oil is reclaimed, it is usually filtered and centrifuged in order to remove metal chips and dirt; it is then heat-sterilized and reused.

In most airplane factories, the workers are provided with as many clean wiping cloths as they may require. The factory has these cloths washed and the metal chips removed; they are then used again by the workers.

Dermatitis is of frequent occurrence in the machine shop. It may be caused by metal slivers cutting the skin and the subsequent development of infections resulting in boils. Since some workers spit into the oil reservoir of the machines, and since even *Bacillus*

[1] The burns resulting from hydrofluoric acid are not felt until several hours after contact. The resulting ulcers are painful, and show but little healing tendencies. Curetting the base, followed by septic dressings, is required to heal them.

coli has been isolated from cutting oils, it cannot be said that cutting oils do not contain bacteria but they do not contain more bacteria than is usually found on the skin. Infection is more likely to occur from bacteria present on the skin than from bacteria in the oil because pure mineral oils are unsuitable culture mediums for bacteria, and those cutting oils that contain animal or vegetable oils also contain antiseptics.

Folliculitis on the extensor surfaces of the forearms and the thighs is a frequent form of dermatitis from cutting oils. It is usually caused by long contact of the skin with oil-soaked sleeves and trousers. The oil plugs up the follicles of the skin causing comedones and acne, and secondary infection may follow causing either folliculitis or boils.

Occasionally a worker becomes allergic to something in the cutting oils and develops an eczematoid type of dermatitis. Antiseptics and preservatives in cutting oils are sensitizers and may be the actual causes of the eczematoid type of cutting oil dermatitis. Some workers exposed to cutting oils and greases develop small, flat, brown, slightly elevated papillomata on the dorsum of the hands and forearms.

Those cutting oils which are composed principally of mineral oil also have a defatting action on the skin tending to make it dry and chapped

To prevent dermatitis from cutting oils, the oil should be frequently changed and no additional antiseptics or preservatives should be added to them If they are reclaimed they should be filtered neutralized and heat sterilized The workers should have daily changes of clean working clothes and should wear sleeves, aprons, and coveralls of impervious material to prevent soiling of the clothes. Showers should be provided for cleaning up after work. The workers should be supplied with clean wiping cloths, free from metal chips. Those who have chapped dry skins should rub into the hands before and after work an ointment consisting of lanolin and olive oil. This ointment acts to fill the pores and prevent the entrance of the irritating cutting oil. If a wetting agent is incorporated in the lanolin-olive oil mixture it will aid in emulsifying it and removing it from the skin after work. The use of strong soaps solvents, and bleaches for skin cleansing purposes should be prohibited The sulphonated castor oil-wetting agent mixture described above is recommended as a substitute.

The tooling department in which jigs and dies are made, also uses cutting oils and the workers are subject to the same hazards as in the machine shop In addition to this, the workers in the jig department also come in contact with painted metal parts both dry and wet and dermatitis from zinc chromate paint was found among them

The routers cut flat metal sheets into the desired shape by guiding electric cutting tools, fixed to a movable arm along the edges of a pattern fastened on top of the sheets of the metal. The routers are

sprayed with the cutting oil thrown from the cutting tool. Their clothes become saturated with this oil and cutting oil dermatitis has been found among them. Routers should also observe the precautions given above against cutting oil dermatitis.

Magnetic Inspection.—Bolts and screws are inspected for cracks and other flaws by dipping them in kerosene containing filings of iron oxide. They are then placed in a machine called a magnescope. When the current is turned on the particles of iron are deposited in whatever cracks there may be in the metal piece that is being tested thus revealing the flaws. The parts that have been inspected and found to be flawless are then washed in Stoddard solvent and after drying are dropped in a dye solution consisting of methyl violet in wood alcohol which dyes them and shows that they have been inspected and found to be perfect.

Dermatitis may occur in the magnetic inspection department from the defatting action on the skin of the kerosene and the Stoddard solvent. Allergic dermatitis may also be caused by methyl violet[1] although no cases were found in this study. There is also a hazard of poisoning from the fumes of wood alcohol given off by the uncovered tank of dye solution. Workers engaged in magnetic inspection should wear impervious gloves sleeves, and aprons. Ordinary rubber gloves are easily affected by the petroleum distillates. Therefore, it is recommended that the gloves be made of synthetic rubber which is less easily affected or of polyvinyl alcohol (Resistoflex) which is not affected at all by petroleum solvents. Sleeves and aprons of impervious material should also be worn.

Paint Shop.—Painting is usually done by the spray method in booths and the back wall of the booth has an air exhaust appliance to pull the fumes of the thinner and solvents away from the worker. In some of the paint shops there is a continuous sheet of water flowing along the entire back wall back of which the exhaust fan is located so that the fumes are pulled through the sheet of water which collects some of the ingredients of the paint. In some of the factories, these are recovered from the water. In spite of the exhaust ventilation, there is a strong odor of the thinners and solvents in the paint shop. Toluol turpentine and petroleum distillates are the principal thinners used in the paints. The pigment is usually zinc chromate. The paint also contains a drying oil and a resin. Dermatitis may result from the defatting and sensitizing actions of the thinner on the skin and from hypersensitivity to the resin and the zinc chromate. The workers in the paint department should wear gloves, sleeves and aprons made of an impervious material such as described under magnetic inspection which is not affected by the thinner and solvents. They should also be furnished with an ointment consisting of anhydrous lanolin and olive oil to rub into the skin before and after work. Those workers whose skins already show the drying cracking effect of these solvents should be pro-

[1] Schwartz, Lou. Skin Hazards in American Industry Part I. Pub. Health Bulletin No. 215. U. S. Government Printing Office p. 23, 1937.

vided with the sulphonated castor oil-wetting agent mixture described under anodizing for washing the hands instead of the ordinary soaps and cleansers.

Passivating.—The tanks containing nitric acid solution in which this operation is performed should be closed and vented and the workers around it should wear impervious sleeves, aprons and gloves to protect them from the fumes of nitric acid

Planishing.—Planishing consists in smoothing dents from small metal parts by means of electric hammers. Oil and grease are used on the metal parts and the workers become splashed with the oil They should wear protective clothing sleeves gloves, and aprons to protect them from oil dermatitis.

Plaster Shop.—Here the men are engaged in making plaster casts in which the molds are made. A compound consisting of stearic acid in coal oil is put on the plaster to prevent it from sticking to the molds Dermatitis develops among some of the men from the defatting action of the coal oil It would be advisable to substitute a vegetable oil such as castor oil or linseed oil for the coal oil in order to prevent dermatitis.

Plating.—Only cadmium plating is done. The parts to be cadmium plated are first sandblasted and then degreased by washing in strong alkali soap. They are then dried and immersed in a plating solution which contains about 4 per cent of sodium cyanide The plating tanks are usually well vented but accidental splashes and drippings from the metal parts may fall on the workers. Therefore, they should wear protective clothing in the form of impervious gloves sleeves and aprons, and it would also be advisable to have them insert vaseline into the nostrils to prevent possible nasal mucitis from cyanide fumes that may escape from the tanks.

Tubing Department.—In the tubing department, workers cleaning and painting tubes should wear aprons, sleeves, and rubber gloves because dermatitis has occurred among workers from the cleaners and paints. Some cases have also occurred from copper tubing probably caused by the lacquer which is applied to some of the tubing

Oil is run through the tubing which constitutes the chassis of the fuselage of the plane, in order to act as a protective against rust. The workers engaged in this operation are splashed with the oil and should wear gloves boots, aprons and sleeves of an oilproof material

Welding.—Metal parts are welded together by electric welding by oxyacetylene welding or by the so-called spot welding Parts made of dural or of stainless steel are welded together by the use of fluxes containing fluorides. The workers lean over the flame of the welding torch and their faces are exposed to the fluoride fumes given off during the operation. Nasal mucitis, as evidenced by nose bleed and ulceration of the nasal septum occurs among these workers. They should insert vaseline into the nostrils several times a day to prevent this condition

In spot welding a mixture of hydrofluoric acid and tragacanth

is brushed on the metal to act as a flux. The men brushing it on and washing it off should wear rubber gloves, impervious sleeves, and aprons to prevent hydrofluoric acid burns, and they should also insert vaseline into the nostils These same precautions should be observed wherever a flux containing a fluoride zinc chloride, or chromic acid is used

Wood Shop —Here the various parts requiring wood are made. In some of the wood shops, dermatitis has occurred from a wood known as Honduras mahogany or to the workers as "Tobacco mahogany because of its irritant properties. The dust of this wood is said to be irritating to a considerable percentage of the workers. Only such workers as are known to be non-susceptible should be permitted to work with this wood.

X-ray —Many of the metal parts of the plane are X-rayed for defects. The machines used are powerful and totally enclosed and those handling them are well protected against X-ray exposure No dermatitis or burns of the skin were found in this department.

Zinc Chromate.—Zinc chromate is the pigment that is used to the greatest extent on the metal parts of airplanes. It is applied both for purposes of a filler and a paint. It is sprayed on or applied by hand brush. Several cases of dermatitis were found among persons showing by patch test a hypersensitivity to the zinc chromate itself The prevention of dermatitis from zinc chromate has been mentioned previously under the discussion of hazards occurring in the paint shop

ANIMAL BREEDERS KEEPERS AND DEALERS

Breeders of animals, pet-shop dealers, tenders of animals on farms (see Agricultural Laborers) menageries and circuses, as well as laboratory workers (*q v*) are subject to the infectious diseases of the animals they handle The following may be contracted from domestic animals and fowls anthrax glanders, foot-and-mouth disease noma contagious pustular stomatitis, dermatitis contagiosa pustulosa canadensis, avian and bovine tuberculosis, brucella eruption botryomycosis (see chapter on Bacterial Infections) trichophytosis, actinomycosis and blastomycosis (see chapter on Mycotic Infections)

Many of these infections may also be caught from wild animals for example trichophytosis from deer and anthrax from camels. An epidemic of anthrax was reported in the London Zoölogical Gardens in 1920

Pigeon fatteners who blow grain from their mouths into the open beaks of pigeons may develop pulmonary aspergillosis, which resembles tuberculosis The infecting fungous is *Aspergillus fumigatus* Infection occurs either from contaminated grain or from the aspergillosis chancre which appears as a white, pea-sized caseous lump in the lower part of the bird's mouth

Psittacosis often becomes epidemic among parrots and parakeets,

and affects breeders, dealers, transporters, and other handlers of the birds.

Animal scabies, due to subvarieties of the *Sarcoptes scabiei* (*S bovis* *S canis*, *S dromedarii*, *Dermanyssus gallinae* etc.) can be transferred to man from wild and domestic animals such as horses, cattle, pigs, sheep, goats, dogs, cats, chickens, canaries, pigeons, lions, tigers, camels, wolves, llamas, wombats, monkeys, and foxes. The disease may attack attendants in menageries and circuses, kennelmen pet-shop keepers, workers in veterinary hospitals and homes for stray animals, and breeders of poultry and stock.

Pigeon ticks (*Argas reflexus*) fowl ticks (*Argas persicus*) and ticks of dogs, cattle and other animals may infest breeders and tenders, producing local inflammatory lesions or transmitting infectious diseases. Keepers and trainers of dogs are subject to dipylidiasis which is transmitted by the dog flea, and echinococcus disease by accidentally ingesting the eggs from the mouths and excretions of dogs. Wood ticks deer flies, and other insects may inoculate man with the *Bacterium tularense* from infected animals. Rocky Mountain spotted fever is believed to be transmitted by ticks. The disease has been observed chiefly among sheep breeders in Montana and Idaho.

Creeping myiasis, caused by the larvae of *Cochliomyia macellaria* and myiases which attack the natural body cavities occur among breeders of domestic animals, especially breeders of sheep

Grain itch may arise from *Pediculoides ventricosus* in hay and straw used for the feeding and bedding of animals. (For further data on the above diseases, see chapter on Insects and Animal Parasites.)

Tetanus may be contracted if the excrement of animals enters a break in the skin.

Breeders of venomous snakes for the manufacture of therapeutic serums, *e g* in the laboratories of Brazil are subject to bites from the reptiles as are snake hunters and laboratory workers.

ARTISTS (PAINTERS AND SCULPTORS)

Turpentine used for mixing paints and cleaning brushes, canvas, and hands may cause dermatitis. Women engaged in decorating pottery develop dermatitis, rhagades, and sometimes painful ulcers from the solvents used to thin their paints. The cutaneous symptoms may be accompanied by headache coughing and vertigo The hands and forearms first become dry ridged and sometimes swollen, and assume a pinkish color The nails become thin furrowed brittle and painful (See Pottery Workers.)

Sculptors working with plaster of Paris (calcium sulphate) frequently suffer dehydration wrinkling and cracking of the skin which may become ulcerated

Sculptors are also subject to the occupational diseases that affect stonecutters Callosities of the hands occur from the pressure of

tools and scleroderma may result from handling chisels in cold weather Eczema of the ear irritation of the nasal and oral mucous membrane and ulceration of the cornea and conjunctiva occur from the dust given off in working stone. Dead fingers from using pneumatic tools is a transitory affection resulting from a combination of muscular strain on the fingers holding the tool vibration of the tool and the action of cold

In the process of polishing stone poisoning may occur from the absorption of lead or oxalic acid in the materials used. (See Stone Workers.)

AUTOMOBILE WORKERS

The most frequent causes of dermatitis in automobile factories are the insoluble cutting oils solvents used for degreasing and rust preventive chemicals and processes. The fluids used in hydraulic brakes have also caused outbreaks of dermatitis. Among those engaged in body building the paints, lacquers, paint thinners, alkaline cleaners, and polishes are the principal skin hazards.

AVIATORS

Airmen sometimes develop skin changes consisting of roughness and dryness resembling shagreen pigmentation, and dermographism

Frost-bite occurring at high altitudes has been described by R Prosser White, who observed a number of atypical form during the World War for example, a case characterized by intense pain which lasted three weeks and prevented sleep but without subsequent gangrene.

Through the accidental bursting or leakage of gasoline tanks the clothing of aviators may become saturated and after prolonged contact with the skin an erythematous and vesicular dermatitis occurs which affect the legs thighs and feet.

Aviators who spray insecticides on trees and other vegetation run the risk of dermatitis and systemic poisoning from lead arsenic and toxic gases.

BAKERY TRADE

The introduction of modern machinery and technological methods in the larger baking plants has revolutionized conditions in the industry and greatly reduced the occupational diseases of bakers. However many small concerns still exist which employ little or no mechanical equipment The work is done by hand and very often in unsanitary surroundings Fatigue from long hours heavy labor involved in tending the ovens, carrying sacks of flour etc. and exposure to heat and dust lower the workman s resistance and make him unduly susceptible to disease

Bakers are subject to cutaneous lesions from trauma heat, burns etc. similar to those described for cooks confectioners and pastry cooks (q v) In most bakeries cakes and pastry as well as bread are made and dermatitis may be provoked among sensitive workers

by contact with the various ingredients used. The authors have found patients in this occupation who react to patch tests with one or more of the following substances: spices, sugar, vanilla, lemon and cinnamon. One baker yielded positive reactions on patch tests with whole wheat flour and white bread flour (Fig. 113.)

Baker's Eczema (Baker's Psoriasis).—A classic form of eczema attacking bakers has been observed for over a hundred years. In this country at present the case reports are few and far between but in Europe, and especially in Germany, the incidence is much greater.

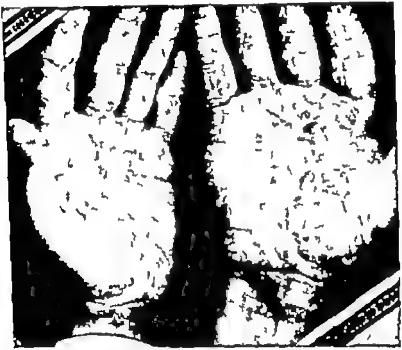

FIG. 113.—Cinnamon dermatitis in a baker.

The disease starts with a sensation of burning and some degree of itching on the anterior and cubital surface of the forearms and on the backs of the hands. From this stage it progresses to become an acute or chronic dermatitis. The acute condition, is characterized by small vesicles, which later rupture and weep. Pruritis is severe and is greatly exacerbated when the parts are exposed to heat. In the chronic form the skin becomes thickened, with scaly or weeping patches. Secondary infection often gives rise to deep-seated pustules.

The lesions are generally bilateral but frequently spread through scratching and autoinoculation to the face and genitals, and sometimes over the whole body. R. Prosser White stresses the importance of distinguishing the occupational disease from the seborrheic,

eczematous, lichenoid and psoriasiform types of dermatitis and from the erythematous, papular vesicular and pustular eczema.

The condition is very resistant to treatment especially in elderly persons. Many cases continue for months and relapse even in the absence of contact with working materials.

The etiology is still obscure although numerous theories have been advanced. The probability is that not one but many factors are involved in its production.

Fig. 114. Baker's dermatitis caused by flour conditioner. (Case of Dr. John Godwin Downing.)

Flour improvers, chiefly ammonium persulphate have been blamed although examination of workers engaged in manufacturing (Fig. 114) this material has revealed no skin lesions resembling baker's dermatitis. Improvers, which are used to accelerate the activity of yeast growth commonly consist of the following chemical compounds:

"Elco"—potassium bromate plus magnesium carbonate
"Porit"—ammonium persulphate plus calcium acid phosphate
"Clutin"—"Elco" plus "Porit"
"Secalit"—calcium acid phosphate
"Multaglut"—ammonium persulphate plus calcium acid phosphate

It is not customary in America to mix these improvers with flour intended for bread-making before the flour is sold to the baker

Flour bleaches are employed to remove the yellow color caused by carotin ($C_{40}H_{56}$) This is done by exposure to air and sunlight, and by various chemicals of which benzoyl peroxide and nitrogen peroxide are the most effective. Flour treated with nitrogen peroxide gives off vapors of nitrous acid. Bleaches are used more extensively in Germany than in the United States due to the inferior grade of flour available in that country

Eczema has also been attributed to allergy to flour itself but no such cases have been discovered in flour mills where the workmen are most exposed to it. Sugar and salt have also been blamed.

Goldsmith states that there is a definite relation between the occurrence of dermatitis and the hand-kneading of hygroscopic dough Removal of the dried and hardened masses, especially from the hairy regions, produces abrasions which become further irritated by dust, heat, and microörganisms.

The flour and dust, plus heat, perspiration maceration, and friction produce a mild form of miliaria. This is associated with pruritus, and scratching brings on an eczema with secondary folliculitis and abscess formation. It has been observed that cleanliness and good ventilation overcome this condition.

Acari of the Tyroglyphus family which infest inferior grades of sugar and the *Sphaerogyna cerealella* found in barley often attack bakers and cause pruritus which by scratching may lead to secondary eczema. Baker's eczema, itch and eczema arising from the itch sometimes occur simultaneously in the same patient.

Lack of cleanliness and numerous small cracks in the skin encourage the formation of boils, paronychia cellulitis, and lymphangitis.

The fingers may be the site of localized lesions, for example, paronychia from the action of flour and baking powder and a characteristic callosity on the palmar and cubital surface of the little finger produced by friction against the kneading board

Dental caries and lesions of the oral mucous membrane are said to be common among bakers, and are attributed to the dust of flour and in less degree, to sugar (See Sugar Industry) Blepharitis, conjunctivitis, and external otitis also occur probably from the same cause

It seems clear that improved ventilation, scrupulous cleansing of utensils and premises, and the encouragement of personal cleanliness, including the mouth and nails, will go far towards reducing diseases of the skin among these workers. Few occupational diseases are reported in large, up-to-date plants.

BARBERS AND COSMETICIANS

Barbers, hairdressers, and employees of "beauty parlors" come in contact with numerous substances in their work that are capable

of causing dermatitis and may also contract mycotic and bacterial infections from their customers or infected equipment. Barbers cosmeticians etc. are liable to dermatitis from irritants in any of the numerous cosmetic preparations which they handle, and the reader can refer to the section on Cosmetic Irritants for a full list.

Barbers are exposed to anthrax from infected shaving brushes. Aside from this, they share the same skin hazards as hairdressers. (Fig 35) If rubber gloves are not worn frequent immersion of the hands in soapy water for shaving and shampooing may produce dermatitis and onycholysis due to maceration by the soap solutions. Many shampoo preparations contain such alkalis as borax and baking soda Manicurists generally apply liquid nail polish with a small brush and wipe away the excess with the thumb while polish remover and cuticle remover are often applied with the unprotected finger Alkalis, triethanolamine salicylic and oxalic acids and acetone in these preparations sometimes cause smarting and inflammation of the skin after prolonged contact.

Dyes have been responsible for the most serious damage among hairdressers especially those preparations that contain paraphenylendiamine. (Fig 36) The fingers and hands and sometimes the forearm are affected

Dermatitis has been reported from contact with silver hair paint having an aluminum base Hydrogen peroxide used for bleaching the hair may irritate sensitive skins and cause loosening of the nails. Cases of dermatitis have been reported among hairdressers using permanent wave and wave-setting solutions, whose irritant ingredients were not definitely known. The formulæ for these patented preparations is often kept secret Dermatitis of the palms and interdigital webs has been reported among barbers from contact with colocynth used as a denaturant in alcohol and also from methylated spirit.

Rubber gloves are often themselves a source of skin irritation If worn while handling hot liquids they retain the moisture of sweating and tend to macerate the skin. Lesions present on the hands are aggravated and splashings from chemical irritants in the dyes or other solutions may seep over the free end of the gloves and cause dermatitis. Dermatitis has been produced by bakelite bottle caps and other fittings.

Infections are readily incurred by employees of barber and beauty shops from customers suffering from contagious skin diseases. Ringworm favus staphylococcus and streptococcus infections and even syphilis have been conveyed to barbers and cosmeticians in this way Impetigo contagiosa may be contracted in barber shops, and tinea circinata of the thumb has been reported in a barber Tinea sycosis, or "barber's itch" may spread in barber shops both to other patrons and to the operators when the shaving materials are used in common Despite the use of individual cup soap brush and razor for each customer sharpening the razor on a common strop is sufficient to pass on the infection

Shaving brushes are a source of infection not only with anthrax spores but with the germs of contagious diseases transferred from the customers. The brushes are difficult to sterilize without loosening the hairs, and sponges have been employed as a substitute. These are damaged by hot alkaline solutions which offer the only easy method of sterilization and use of cotton wads wrapped in gauze has been recommended since they are inexpensive and can be discarded after each operation. Razors, scissors and clippers are often found to be infected from contact with diseased skin and should be sterilized by boiling before and after use. Brushes and combs should be disinfected by immersion in a 10 per cent ammonia solution at a temperature of 80° to 104 F

Ideally the garments of the operators and all the articles used should be sterilized before each operation. This is the best means of protecting the workers as well as the patrons. The use of such poisonous substances as lead, mercury arsenic and paraphenylendiamine in cosmetic preparations should be prohibited by law Many cities and states have such laws.

BARREL WASHERS

Barrels and metal drums and containers are used over and over Before new substances are put into them they must be cleaned The cleansing solutions depend on the previous contents of the container Hot solutions of sodium carbonate trisodium phosphate and soaps are often used. In some instances solvents are also used Bleaching solutions and deodorants such as sodium hypochlorite, *calcium hypochlorate ammonia etc.* may also be used All these cleansers can cause dermatitis. Barrel washers should wear rubber boots, rubber gauntlets, and long rubber aprons.

BARTENDERS

Bartenders have their hands in soap solutions and other cleansing solutions for washing glasses. They may develop dermatitis and paronychia from the keratin softening and fat emulsifying properties of these solutions. In addition to this the above bartenders polish brass work and woodwork and the polishes may cause dermatitis.

Bartenders should wear rubber gauntlets when washing glasses and soft leather or fabric gloves when polishing brass. An emollient cream with a lanolin base rubbed into the hands several times a day will tend to keep the skin from being affected by the cleansing solutions.

BASKET WEAVING AND ALLIED OCCUPATIONS

Many types of baskets, utensils, furniture chair seats, baby carriages and pony carts, rope matting hats, etc. are made by weaving thread-like or tape-like flexible fibers of vegetable origin. The material consists of branches, twigs, stalks, weeds, grass, straw

bark chips and strips of fiber derived chiefly from the following plants

Wheat (*Triticum æstivum*) rye (*Secale cereale*) oats (*Avena sativa*) buckwheat (*Sorghum vulgare*) rice (*Oryza sativa*) grass (*Typha latifolia*) sword grass (*Carex riparia*) salt grass (*Carex cæspitosa*) rushes (*Scirpus holoschœnus* and *lacuster*) willow (*Salix viminalis purpurea alba* and others) raffia (*Raphia textilis*) jute (*Corchorus olitorius*) coconut plant (*Cocus nucifera*) and malacca cane (*Calamus rotang*) The framework for baskets and some other woven articles is made of the less flexible parts of plants or of wood

Hand work is still the rule in this industry and the cutaneous lesions are limited almost entirely to the hands. Most of these are due to physical causes such as trauma friction and pressure although other hazards exist in the form of mycotic infections and dermatitis from the essential oils of certain plants.

Callosities are very numerous. From pressure against the fiber the thumb becomes thickened flattened enlarged and covered by keratosis A permanent curvature of the first and second phalanges of the fingers of the right hand is often seen among these workers. Callosities occur among flask-coverers on the radial side of the little fingers together with a thick callosity at the base of the right palm over the carpo-metacarpal joint caused by friction of the end of the large needle used for this work In fact all the workers exhibit these lesions, varying in location and severity with the kind of operation carried out and the hardness of the materials handled.

Superficial cuts received from the fibers are so numerous that the palms of old workers are covered with transverse scars and new wounds which become darkened by deposit of foreign matter and present a striped appearance Deeper cuts sometime occur which may give rise to troublesome fissures that force the worker to leave his job Suppuration, however is rare

Fungous infections are incurred by workers who use rattan canes for the weaving of large baskets A fine white mold is shaken out when the cane of *Calamus rotang* or *Draco* (the Elanewel of the West Indies, known to the trade as Pontyanac) is hammered split or cut. This often covers the hands and causes many painful but superficial fissures on the palms and fingers, affecting only the longitudinal creases. R Prosser White states that this type of rattan is the only one that carries this hyphomycete so far as he has been able to observe

The reeds of Provence used to make sieves, trellises and paneling for ceilings, when piled up in heaps develop a dry white mold *Sporotrichum dermatosus* which produces a severe eruption among workers who strip the stalks. The lesions appear on all parts of the skin on which the mold falls and are characterized by pruritus, erythema edema and vesicles accompanied by slight fever and headache This infection can easily be avoided by wetting the canes before they are removed from the heaps.

A somewhat similar dermatitis has been reported among workers who wrap matting around bottles and among those who make the seats of cane-bottomed chairs. R. Prosser White suggests that the *Scopulariopsis koningii* may be responsible in these cases.

Molds such as *Mucor mucedo*, *Rhizopus nigricans* and *Aspergillus glaucus* have been reported to produce skin lesions.

Plant oils may cause dermatitis among some workers, for example, the dermatitis occasionally seen among men who make rope of pine chips. Freshly cut chestnut and hazelwood containing tannin produce painful fissures of the hands among sensitive persons and may necessitate a change of occupation.

Eruptions are sometimes caused by mechanical irritation such as the manipulation of a rush plant (*Carex stricta*) whose leaves have fine sawing and cutting edges made harder by the presence of silica in the superficial cells.

Gingivitis and herpes labialis have been reported among workers who have the habit of holding strips of wicker between their lips.

Many of the substances used in the manipulation of the materials are capable of causing dermatitis. For example, fish oil used to lubricate jute and make it more pliable liberates volatile fatty acids when it decomposes, and cases of dermatitis among jute workers have been attributed to this cause. Workmen who finish the baskets and other articles may develop lesions from solvents lacquer varnishes, and coloring materials.

The need for some protective covering for the hands in these occupations is obvious, but many of the workers believe that gloves hinder the speed and precision of their movements. In some cases they cover the most exposed parts of their hands with pieces of cloth or leather

BATH ATTENDANT

Occupational dermatitis may occur among bath attendants, especially those who give massages and "rub downs," from the oils, liniments and tonics which they apply manually Mycotic infections of the hands, and paronychia may result from contact with infected skin of those being treated Mycotic infections of the feet ("athlete's foot") is not spread by fungi on the floors. It is rather the result of the favorable conditions of growth which moist interdigital spaces afford the fungi. Bath attendants should wear wooden sole bathing clogs, and they should keep the feet and interdigital spaces dry

BATTERY MAKERS

Workers making wet storage batteries may get burns and dermatitis from the acid solutions used in the batteries. Acne, folliculitis and keratoses may occur from the pitch which is sometimes used to seal and insulate the batteries. The fiberglass plates in the cells may cause dermatitis among workers cutting them to size and placing them into the batteries. Protective clothing rubber gloves,

for acid and pitch exposures and personal cleanliness will eliminate these hazards

Dry battery makers come in contact with benzol sulphuric acid phenol pitch zinc chloride and mercury compounds all of which may cause dermatitis

BLEACHER

Many irritant chemicals are used in bleaching Materials to be bleached are usually washed clean with strong soaps or solvents. The actual bleaching solutions such as chlorine compounds sulphur compounds oxalic acid per salts which give off nascent oxygen are all potential skin irritants. Workers in bleaching rooms, should wear rubber boots, and rubber gauntlets. Workers performing individual bleaching jobs such as straw hats where oxalic acid is used should be particularly careful to prevent soiling of the skin with the acid It has caused destruction of the nails as well as dermatitis

BOOKBINDING INDUSTRY

Bookbinding may be divided into three classes (1) Publisher's or printer's binderies engaged in large-scale production which use automatic machinery for practically all operations (2) binderies doing miscellaneous jobs and employing both machinery and hand work (3) shops engaged in binding blank books limited de luxe editions of new books, and rebinding old books.

After being printed and folded the books are stitched together with thread and a strip of gauze is sewn over the stitched edge. Over this is glued a strip of paper The covers are made of pasteboard covered with cloth or leather and are fixed to the book by glueing to the edges of the gauze strip The first and last pages of the book also are pasted to the covers

The free edges of the pages are often colored by means of a brush or spray and the tops of some fine books are gilded with a hand brush Marbling is done by dipping into colored ink In some cases book covers are finished with shellac or lacquer by spraying

Dermatitis in this occupation is acquired mainly from the irritating ingredients and solvents of the glue. R Prosser White mentions oxalic acid as a probable cause of dermatitis and Lutz in 1930 has reported several cases of dermatitis localized to the first and second fingers, caused by 0.5 per cent of formalin added to a benzene wash

Shellac is a potential irritant, as are the inks and coloring materials used for the edges.

BOOT AND SHOE MANUFACTURE

The making of boots and shoes is today largely done in big factories employing hundreds of workers. The old-fashioned method of hand shoemaking is still carried on to some extent by cobblers, especially in some European countries, but it is on the decline. Many of these cobblers who are trained from father to son come to

the United States where they are employed in factories producing high-grade shoes.

Dermatitis and occupational stigmata occur among the cobblers. Chief among these are cellulitis following infection of abrasions and punctures of the fingers. Keratosis painful callosities, and fibrous swellings result from prolonged mechanical irritation as for example keratosis between the thighs from friction in holding the last stand fibrous swelling above the right knee due to frequent hammering and callosities arising from the pressure of knives and hammers.

The universal custom among shoemakers of holding nails in the mouth causes caries of the incisor teeth. Lead poisoning buccal syphilis, and even epithelioma are also said to have resulted at times from this unsanitary habit.

A frequently described deformity is the depression of the lower half of the sternum ascribed to constant pressure over the last. Many observers, however believe that this condition is no more frequent among shoemakers than among general population.

The hazards met with in the large factories are essentially similar with added ones due to the use of certain machines and the dyes, cements and solvents employed in some of the processes.

According to the report of the United States Department of Labor on occupational hazards issued in September 1933 shoe factory operatives are subject to injury of the skin from organic dusts, and the finishers in particular incur cutaneous risks from ammonia amyl acetate amyl alcohol, methyl alcohol, benzine and benzol employed as solvents for the various cements.

Sole stitchers who operate the Blake machine which is lubricated with a mercury paste are said to be in danger of mercurial dermatitis and poisoning Dyers are subject to injury from nitrobenzol

A neurotic condition of the hands known as "white fingers" or "dead fingers similar to that seen among operators of pneumatic hammers, sometimes occurs among polishers due to the strong vibration of the machine when they hold the work with both hands forcibly against the polishing wheel (See White Fingers.)

An occupational stigma recognized since the time of Hippocrates as typical of shoemakers is a cut on the right thigh from the knife used in cutting the leather

Oppenheim describes pigmentation and comedones on the chests of shoemakers from the handling of coal and petroleum products. R Prosser White mentions the occurrence of anthrax from handling infected hides, although this hazard is not present in the modern shoe factory where the leather is thoroughly disinfected before it is received.

In the large factories one single operation is handled by the same worker more often than in the cobbler's workshop where shoes are made by hand and thus may exaggerate the stigma or dermatitis which occurs as a result of that operation. On the other hand the worker escapes the risks that may exist in many other operations. The hygienic conditions of the modern plants are a[illegible]

to those under which the old-fashioned cobbler usually worked thus minimizing many of the dangers attendant upon the work.

The authors have been able to observe the manufacture of shoes in a factory making high-grade footwear for women and employing over 400 workers.

Two different processes are employed the "compos" and the "hand-bench" process. Many of the operations are the same in both but with the hand-bench method a great part of the shoe is made by one worker while with the compos method different workers handle different small details.

The hand-bench process is similar to the compos process in the handling of material for making the uppers while in the latter the *laster* and *soler* complete the rest of the shoe. These men use waxed thread tacks cement, and fish glue.

The leathers come to the factory already tanned and dyed. Most of them are chrome tanned but some are alum or vegetable tanned. Black and navy blue leathers are aniline dyed The others are dyed with a neutral colored base and later colored to the desired shade The leathers used are varied including kid calf kangaroo antelope reptile, and many others. Kid only is dyed with aniline the calf and other dyed leathers being treated in another way (See chapters on Leathers, Tanning and Dyeing) Although dermatitis has occurred from handling tanned basic dyed calf skin leather used for soles no cases have been seen during the inspection of this factory

Cuts among those who handle the knife and callosities among workers at various operations which entail localized pressure or friction are the lesions most frequently observed

During their work the lasters hold in their mouths the tacks which they take out and hammer one by one through the leather into the insole and the last. The tacks have fine metal slivers that shave off and cause soreness cracking and peeling of the lips which the workers usually try to relieve by applications of cold cream. The authors have observed slightly bluish pigmented dots on the lips of these men.

A vesicular dermatitis occurred on the right hand of an operator of an automatic machine which applied Dupont Compos (formula not ascertainable) to outsoles. A special cement solvent was used for the brushes and to remove the cement from the hands. However this worker experienced no further trouble after using a protective cream and gloves. Also a solvent formerly used for compos cement caused dermatitis.

Dermatitis was noticed on the hands of all the workers employed at touching up defects in color of the finished shoes with crayons, dyes, powders, gold and silver dusts, and solvents. It was ascribed to handling the compos cleanser

Serious cases of dermatitis are comparatively few in the plant inspected although many potential irritants are handled which may give rise to dermatoses.

BRIQUETTE MAKER

Briquettes are used in some parts of the country for heating and cooking.

They are made of powdered or fine particles of coal mixed with coal tar pitch and pressed into shape in molds.

Workers at this occupation are subject to all the skin hazards connected with handling coal tar pitch, i. e., pitch acne, melanosis, keratoses and epithelioma. The preventive measures consist in daily change to clean work clothes, compulsory showers after work, etc. (See Coal Tar.)

BROOMS AND BRUSHES

While most of the operations involved in the manufacture of brooms and brushes can now be done by machinery, a considerable amount of hand labor is still employed for certain processes in which there is contact with substances capable of producing skin diseases. Many blind persons are engaged in broom making and carry out effectively both the hand and machine operations.

The raw materials used are of vegetable and animal origin, chiefly broom corn, horsehair, and bristles of hogs and sometimes wild boars. Hair and fur from such animals as the badger, bear, goat, skunk, squirrel, red sable, and marten are used for many of the finer brushes. The so-called "camel's hair" for commercial purposes comes from a species of Russian squirrel. The fibrous part of whale fins or whale bone finely divided is sometimes substituted for horse hair. Brushes for certain purposes are made of metal wire.

Besides broom corn, such vegetable products as tampico, piassava, coco, cane, kitool, Mexican fiber and palmyra fiber enter into the composition of brooms and brushes.

Wooden handles and brush backs are generally made of alder, beech, poplar, birch, cherry, chestnut, ebony, elm, lime, mahogany, oak, pine, rosewood, satinwood, sycamore, or sabicu. Other materials are bone, celluloid, erinoid, ivory, tortoise-shell, and numerous metals.

The most common material employed for making ordinary brooms is broom corn and its manipulation will be briefly described.

Broom Corn (Sorghum vulgare).—This plant is cultivated chiefly in North America, Africa, and northern Italy. It is a tall grass with long spikes and sharply pointed seeds enclosed in a similarly pointed sheath. After the crop is harvested the workers remove the seeds by beating the stalks or by passage through a wooden sieve. Both operations give rise to great quantities of dust. After the stalks have been dried in the sun they are tied up in bunches and sold to the broom makers.

The work of manufacture is sometimes carried on in the workers' homes, usually under extremely unsanitary conditions. Factory work is done under certain health regulations, although in both

cases the workrooms are generally overcrowded and excessively dusty

The stalks are bleached in a sealed chamber with chlorine or sulphur dioxide fumes for twenty-four hours and then aired to remove the fumes. They are sorted assembled and bunches are attached to the broom handle with wire or a band of fiber. This operation may be done by machinery or by hand. The stalks are then bound together usually by women with a large iron needle and thread of wire fiber or cord and the ends trimmed off evenly with a cutter

Sorting flattening and arranging the stalks of sorghum raises a great deal of dust composed largely of spikes and pointed fragments from the seed sheaths and also parts of the sharp dried seeds that are not entirely eliminated in the beating process.

This dust causes excoriations and dermatitis of the exposed parts. If clothes are hung in the workroom the dust which collects on the inner surfaces causes a generalized dermatitis. Scratching produces a series of sores known as broom maker's disease. These conditions readily clear up when work is stopped

The mechanical irritation of the dust is undoubtedly responsible in large part for these lesions although certain authorities attribute them mainly to parasites with which the straw is infested notably the *Bacillus sorghi Pass* and the *Pyrausta nubilalis Hubn*. No chemical irritant in the plant itself has been demonstrated

When the work of fixing the broomstalks to the rod with metal wire is done by hand callosities are formed on the left forefinger and across the palm by friction of the wire plus deposits of iron oxide. Binding the bunches with an iron needle and metal or other thread causes furrowing of the right palm of women workers despite the usual protection of the skin with a piece of leather. Another callosity is formed at the point of contact with the needle

The hands of all the workers are covered with sores and scratches due to the sharp points of the broomstalks and fibers, the metal wire and cutting tools.

After bleaching the raw material with chlorine or sulphur dioxide it is often manipulated before it has been sufficiently aired. The remaining fumes are extremely irritating to the mucous membranes of the upper respiratory passages and may produce dermatitis.

Trouble from these sources can be minimized by performing all dusty processes by machinery and placing hoods over the breaking machines. In some factories dust is reduced by wetting the plants before breaking

After bleaching exposure to sunshine and air should be continued long enough to eliminate the acid fumes completely

Animal Products.—Horsehair hog bristles and other animal hairs are used chiefly in the manufacture of brushes especially shaving and paint brushes and to a lesser extent for brooms. Fine art brushes are made of hair from the red sable badger bear and Russian squirrel.

The most serious danger in working with these animal products especially horse hair is anthrax. To prevent this the hair is cleaned and disinfected on arrival at the factory by boiling in an autoclave, or by a solution of formaldehyde.

Prior to disinfection the hairs should be handled only after being moistened, and those engaged in sterilization should wear overalls head coverings, and a respirator over the nose and mouth

The bundles are opened on sorting tables, foreign matter eliminated and the hairs separated according to their size, quality etc. Next they are combed the hairs being held in the workman's hand and the comb fixed to the edge of the table. In this process much of the remaining débris is removed

The fibers are then tied in bunches to wooden pegs soaked for several hours in cold water and then boiled. After boiling, the hair is placed on trellises in a heated chamber to dry

Dyeing (usually black) is done by soaking in a solution of log wood or aniline dye. When dry the fibers are combed again cut to the desired length, and mixed according to the combination desired

Bristles are treated in much the same way disinfected, dried sorted combed, and boiled Quantities of dust are disseminated in the processes of beating and sorting For boiling the short hairs are wrapped with hemp or jute. Hog bristles are sometimes accompanied by fermentation, which produces a nauseating odor

When bleaching is necessary it is done by sulphur dioxide fumes or other bleaches such as peroxide of hydrogen. The bristles are then wrapped in small bundles in a linen cloth firmly bound with string or wire and dried in an oven to restore their stiffness.

The backs or mounts of brushes are made of a variety of materials, *e g* wood rubber horn bone ivory tortoise-shell metal celluloid etc. Holes are drilled in the mount and small tufts of hair or bristle inserted and fixed with glue or tar which has been applied to the under surface of the mount. The mount is then affixed to a piece of material similarly shaped which forms the back of the brush

For long-handled brushes such as paint brushes the fibers are put into a metal holder with a little sand sawdust, or talc to hold them more firmly and the holder is then slipped onto the handle. Art brushes are often set in rubber by immersing the bristles in a solution of pure gum rubber in benzene. They are then dried and laid on trays of sulphur and then go to the vulcanizing oven

In making hair brooms, the wood is perforated and the bristles fixed with a hot solution of Archangel or Swedish pitch The work of fixing is done either by hand or machinery

Brushes are finished by coating the part fixed on the handle with strong glue or copal varnish

In the past, cases of anthrax have been frequently reported in this industry but are becoming markedly fewer as protective legislation is adopted by the various governments. The risk of glanders is now almost non-existent.

Lead poisoning may be incurred from the lead table on which horsehair is generally cut but here also the risk is slight.

Diseases of the skin are comparatively common They are due to contact with dust, heated tar and pitch cement with a tar base colophony or resin shellac in methyl alcohol benzene and other solvents aniline dyes, and bleaching materials such as sulphur peroxide of hydrogen etc.

Opening the bundles and sorting and combing the hairs creates enormous quantities of extremely fine dust containing dried blood mud and dirt. This is deposited on the skin and causes dermatitis and furunculosis. The skin of the face hands, forearms, and the external ear are generally affected

A characteristic dermatitis occurs chiefly among workers who clean horsehair and bristles with hot and cold water comb them while wet and dye them The palms and fingers show a bright red color accompanied by acute hyperhidrosis. It is believed to be due to the hypochlorites in the dyeing solution

Callosities often occur on the fingers from friction with the scissors in trimming hairs The use of wire for binding and also for making some brushes produces rhagades on the left thumb even though the part is protected by a piece of leather

Fumes from pitch and tar cause headache and irritate the mucous membrane of the eyes nose and throat as well as the skin.

Burns may occur while boiling raw materials and handling hot pitch tar and asphalt In 1922 7 cases of dermatitis were reported among a group of 13 workmen engaged in fixing the bristles. The eruptions were found to be due to formalin in the paste.

R Prosser White describes a symmetrical acneform eruption with occasional pustules of two years duration in an employee exposed to splashings of oil from a brush-making machine.

Wood and Accessory Materials.—Woods used for handles and backs of brooms and brushes may cause dermatitis, especially during sawing drilling and the insertion of fibers (See chapter on Plants and Woods.)

Horn bone celluloid rubber and the various metals used for mounting and backing brushes, glues paints, lacquer and varnishes are also possible cutaneous irritants. (For details see these subjects)

BUILDING AND ROAD CONSTRUCTION

Building construction comprises a number of different trades and requires a great deal of manual labor Except on large jobs unskilled laborers carry loads of brick, stone, mortar débris, etc and also do the work *of excavation and filling in for foundations.* The men who carry heavy weights on the shoulder often develop bruises, callosities, and rhagades at the point of *friction* and

structural changes sometimes include the shoulder blade neck and thorax due to habitual weight-bearing on the same shoulder

Those engaged in excavating are exposed to heat, cold and dampness which may produce chilblains, frost-bite sunburn eczema intertrigo, and other skin diseases common to outdoor workers. Tetanus may be contracted from contact with organisms in the soil and ankylostomiasis is a danger in warmer climates. Callosities of the hands arise from friction against tools and the hard substances handled

For large-scale construction, excavation is done by steam-shovels, and hoists and cranes are used for transporting heavy weights. In excavation work, dynamite blasting is a source of traumatic injury from flying particles.

Carpenters are subject to numerous wounds and cuts that often become infected as well as to callosities, bursae and eruptions from irritating woods. (See under Lumber and Woodworking Industries.)

Bricklayers, stone masons, plasterers, cement mixers and hod carriers, workers in reinforced concrete, and others who come in contact with mortar or cement are subject to dermatitis ("cement worker's itch") due to the earthy bases of calcium to sulphuric acid and alumina in the cement.

Plasterers, especially are exposed to much finely powdered dust of lime or mortar which can affect the unbroken skin. The rash is more severe in the presence of perspiration or where there are cuts and abrasions. In the acute form the eruptions may be eczematous and oozing with subsequent crusting while the more common chronic form is papular and lichenified The hands feel dry stiff swollen, and smart severely at night, often preventing sleep The skin desquamates and the nails become thin and friable. Inhalation of cement dust causes ulceration of the oral and nasal mucous membranes.

Tile floors are laid in cement and the tile afterwards cleaned with hydrochloric acid, both of which substances may give rise to irritation of the skin.

Bricklayers suffer from wrinkling of the skin and sometimes from ulcers due to contact with the mortar Laborers who carry sacks of cement often develop dermatitis of the nape of the neck and other parts of the skin that come in contact with the sacks.

Besides injuries from lime, chilblains are said to be rather frequent among stone masons who handle the chisel in cold weather

Paper-hangers may incur dermatitis from aniline dyes or chromium compounds in the wall paper Arsenical dermatitis and lead poisoning from coloring materials have been formerly common in this work, but arsenic and lead are seldom used for the purpose at the present time However danger still exists from this source while scraping off old wall paper containing arsenic or lead This operation raises a great deal of dust, and can be prevented by

moistening the paper before removal. The operation of sandpapering also creates quantities of injurious dust.

It is sometimes necessary to remove varnished tile papers or other painted papers before hanging new paper. This requires sandpapering to abrade the hard surfaces, and is followed by the use of ammonia or washing powder in water.

All walls must be sized before paper is applied. The size consists of glue. There are many prepared sizes on the market, but in some cases the paper-hanger prepares it himself by boiling flaked glue in water. Brown sugar or molasses is added when it is desired to make the preparation more elastic.

The paste for the wall paper is made of flour and water to which Venetian turpentine is added when extra strength is required for hanging heavy paper. Ammonia and turpentine are potential irritants.

Roofers are exposed to inclement weather, the extremes of heat and cold, and sunlight, and may develop dermatoses from these sources. (See chapter on Physical and Mechanical Agents.) They may also incur lead poisoning from soldering metal roofs, and irritation of the skin and mucous membranes from the fumes of hydrochloric acid and arseniuretted hydrogen liberated in this process. (See also Plumbing, Gas and Steam Fitting.) Contact with tar while applying roofing paper and covering roofs with tar and gravel is a source of photosensitivity and dermatitis. Handling creosoted shingles may cause a dermatitis. (See Coal Tar.)

Structural steel workers are subject to numerous accidents especially riveters and acetylene welders. Lead poisoning has been observed among riveters. Affections of the skin as well as systemic poisoning may occur among acetylene welders due to impurities in the acetylene such as arseniuretted, sulphuretted, or phosphoretted hydrogen.

Electric welding and cutting which are now being widely employed in building construction instead of riveting may cause an artificial sunburn or urticaria, as well as serious inflammation and other injuries of the eyes which occur in the absence of adequate protection against the intense ultra violet rays generated.

Painters are exposed to a greater number of skin irritants than any other workers in the building trade, chiefly lead and the numerous solvents such as turpentine, methyl alcohol, amyl acetate, benzene, etc. (See Painters.) Paint containing red lead is often used as a protective covering on structural steel, although aluminum paint which is not regarded as an industrial poison is sometimes substituted.

Electricians may suffer electric burns and shock while wiring buildings and installing apparatus.

Road Builders.—Road builders are exposed to the same skin irritants as are other outdoor workers. These are heat, cold, and sunlight, parasites and bacteria in the soil, mycotic and parasitic

infections when working through woods underbrush and weeds and dermatitis from such plants as poison oak and ivy

Macadamized roads are surfaced with a layer of broken stone, gravel coarse sand and bitumen or asphalt, and then covered by a layer of tar mixed with anthracene oil. The surface is then pressed by a steam roller In towns, wooden blocks are often used to pave the streets, and these are steeped in or sprayed with asphaltic substances.

The tar asphalt, and bitumen are always melted at the roadside and the workers are exposed to coal tar and asphalt fumes from these materials as well as to dust from the dry mixture. The dust and fumes may cause inflammation of the eyes and respiratory passages and a peculiar yellowish pigmentation of the skin. Burns and ulcers may result from accidental contact with the hot viscous mass as it is being spread on the roadway Sequeira states that cancer has been seen in a roadworker engaged in spraying roads with crude tar while laying down macadam (See Coal Tar)

Stone breaking for road work is still done to some extent by hand near the road The stone breakers are subject to contracture of the tendons and deformity of the right hand resulting from prolonged flexion of the fingers holding the hammer The skin of the hands becomes coarse, wrinkled and thickened, with heavy callosities on the palms. In some cases these workers develop hygromata of the palms. The nails of the left hand are constantly worn down by contact with the rough surfaces of the stones and traumatic injuries of the fingers are very frequent.

In the construction of concrete roads the workmen are exposed to dermatitis from cement mixed with broken stone to form a hard firm surface.

On large projects far from any housing facilities, temporary construction camps are often set up for the men. These places are all too often unsanitary and overcrowded and encourage the spread of contagious skin diseases such as scabies, ringworm impetigo contagiosa, pediculosis, syphilis, and other infection.

Men working at dredging in Florida sometimes receive cuts and abrasions on the hands and feet which do not heal but continue to enlarge and become surrounded by a brawny swelling The ulcer may attain the size of an inch in diameter and the edema may extend 2 inches beyond the edge of the ulcer The ulcer oval or circular in form has sharply marginated edges and the surface is covered by a thin crust upon removal of which granulations are seen to arise above the surface of the skin In spite of antiseptic treatment the ulcers continue to grow for from two to six weeks and then begin to heal the whole process occupying a period of from one to three months. There is no pain and but little pruritus accompanying the process.

Men engaged in this work should wear high rubber boots, rubber gloves, and waterproof clothing Cross incision of the ulcers followed by curettement and swabbing with a strong solution of potas-

sium permanganate (1 :50) resulted in rapid cure of the one case in which it was tried

BUTCHERING, SLAUGHTERING, AND MEAT PACKING INDUSTRIES

The butcher in large centers is primarily a dealer whose main occupation is cutting carcasses and selling the meat in small portions. On the other hand, butchers in small communities often combine the activities of slaughtering, skinning, eviscerating, cutting and selling meat on their own premises. In such places the work is usually done under far less hygienic conditions than exist in the larger establishments which operate under stringent regulations.

In the great stockyards an enormous number of workmen are employed and are assigned to specific jobs such as the care and inspection of animals awaiting slaughter, killing, skinning, gutting, inspection of the meat, sausage making, smoking of hams and bacon, rendering and extracting fat, cooking of tripe and meats for canning and soup making, boiling animal débris for industrial use (*e. g.*, bones, hoofs, horns, etc.) as well as the incineration of useless offal.

In typical plants the work is highly specialized and the workmen acquire great skill and speed at their several jobs. The routine procedure is as follows. The animals are brought to the stockyard, examined by veterinarians, and treated if necessary. Sick, injured or otherwise unsuitable animals are killed by the *knacker* who also skins and cuts up their carcasses as well as those of animals already dead of injury or disease.

Suitable animals are then driven into the slaughtering pen and stunned by a blow. As the body falls it is ejected by an automatic mechanism onto the "bleeding-floor." It is next lifted by a hoist to an overhead rail along which it is passed rapidly from one workman to another. Flaying is usually done by several specialists each working with an appropriate knife on a different part of the carcass, so that an animal can be completely flayed in a few minutes and the skin removed intact. In some plants, however, this operation is performed by a mechanical apparatus.

The hides and viscera which are removed by other workmen are passed through side apertures or chutes into special rooms, where they are handled separately.

Inspectors are stationed at points along the line to examine the carcasses for disease and mark defective ones to be sidetracked from the main route that leads to the cooling rooms. Later on, the suspected meat is further examined and passed upon. Carcasses that have been approved are cooled or frozen, packed, stamped, and made ready for distribution.

The risks shared by butchers, slaughter-house men, and associated workers arise from animal diseases such as anthrax, brucella eruption (Bang's disease), foot-and-mouth disease, erysipelas, erysipeloid, butcher's pemphigus, and actinomycosis. (See Bacterial

Infections and also Mycotic Infections.) Knackers, veterinarians, and meat inspectors are especially exposed to such infections.

Anthrax has been reported among veterinary surgeons, slaughterers, butchers, and knackers. The incidence of this disease, however is undergoing a marked diminution

Brucella eruption occurs in stockyard workers and veterinary surgeons who come in contact with infected livestock

Butcher's pemphigus, a somewhat rare disease, is seen chiefly among butchers and their assistants, but may be contracted by any employee who handles the meat of infected animals. It usually follows septic wounds or other injury of the skin.

Foot-and-mouth disease may be caught from cattle, hogs, goats, and sheep although this disease also is rather infrequent in man (See Diseases of the Mouth.)

Erysipeloid is most frequently observed among butchers and fish dealers, although all workers who have to handle meat or fish are subject to the infection. Cases have been reported among smoke dryers, meat inspectors and veterinarians. Swine may be carriers of the bacillus without being ill themselves, the organisms living harmlessly in the pig's intestines and tonsils. Flandin and Rateau, in 1936 described a case of erysipeloid in a pork butcher which began as a tender violaceous macule about 5 cm. in diameter on the back of the hand and later developed blistering and an infiltrate. The lesion gradually spread over the forearm. The course was afebrile.

Acute febrile pemphigus due to handling skins of certain diseased animals, is the human form of foot-and-mouth disease. It starts with a prick of the fingers, followed by an erythematous rash on the throat and by desquamation.

Hog Itch is the name given to a dermatitis occurring among abattoir workers who sort the intestines of hogs which are infested with *Strongyloides lumbricoides* The intestines go through a crusher then through a trough of warm water and then through a roller which squeezes out the residual feces, hog round worms, etc. The worker is required to pick up the intestines and sort and strip them. The hands and arms are frequently in contact with water containing round worms and their ova. The arms, hands, and fingers, are usually affected and sometimes the face from contact with soiled hands. Patch tests with the filtered water from the troughs are usually positive.

The prevention of the condition consists in wearing long rubber gloves over which impervious sleeves are fastened at the wrists to prevent water from entering the gloves. Rubber aprons and daily change of work clothes are also advisable. Removal of the patient from the work and the use of mild medicaments such as boric acid solution on the vesicular types and boric acid ointment on the dry stages will usually result in a cure. Desensitization injections of ascaris fluid in ascending doses may be tried if the patient must continue on the job

Workers engaged in taking the pancreas or "sweet bread" out of carcasses do so with their bare hands using the nails to sever the anatomical connections. The nails become eroded and worn down to the "quick" from the trauma and the keratolytic action of the pancreatic enzyme. Poultry butchers and handlers may develop dermatitis from poultry lice. Bathing and change of clothes after handling poultry is advised

Actinomycosis may be transmitted to man directly by the diseased cattle or by infected straw used for feed and bedding Butchers slaughterers veterinary surgeons knackers and workers who preserve meat are said to be subject to inoculation with the fungus through injured skin or a decayed tooth

Tularemia is a risk among butchers who dress rabbits.

Verruca necrogenica has been reported among butchers slaughterers, flayers and smoke dryers.

Necrotic foci are often found in the livers of cattle and hogs suffering from necrobacillosis. A case of such infection has been reported in a meat inspector

Butchers are subject to boils, carbuncles, localized lymphangitis and cellulitis. "Butcher's dermatitis" is an itchy erythematous eruption which later develops pin-head-sized vesicles. The cause is not known but is evidently an occupational disease and has been proved not to be due to animal parasites.

In 1935 Teleky described a skin disease which attacked 47 out of 300 slaughterhouse workers in Odessa. The greater number of affected persons were employed in removing the skin from sheep's feet. The lesions occurred chiefly on the dorsum of the hands with isolated spots on the forearms face and feet After an incubation period of several days, rose-colored macules appeared and gradually developed into nodules, some reaching 2 cm in diameter A depression, often with a scab appeared later The disease lasted for three weeks and recovery was slow The cause was found to be the virus of variola from an atypical form of sheep-pox then prevalent in the Ukraine 'Orf' is the name since given to this disease.

Rhinoscleroma has been reported from contact with animal carcasses and in Switzerland a woman engaged in sorting dried guts imported from Hungary and Russia developed the disease

Adamson in 1910 described large bullæ of an ecthymatous type of the fingers of women who washed sausage skins. The blisters quickly broke down and left ulcers with a sharply punched-out appearance He called it an ulcerative form of impetigo and found the causative organism to be the streptococcus

Dermatomycoses affecting the beard nails and body are sometimes contracted from animals and are due chiefly to the ectothrix tricophyton of horses, cows and pigs. (See Mycotic Infections.)

In 1908 Matzenauer reported 6 cases of palmar hyperkeratosis among butchers in Vienna who removed the hair from pigs with a

solution of hot water and ream. The skin was thickened about ½ inch and so covered with small pits as to resemble a sponge.

Partial onycholysis of the finger-nails of two pork butchers was observed by Oppenheim in 1934. The affection was due to mechanical irritation while removing bristles from pigs feet immersed in a hot solution of soda. Paronychia has also resulted from contact with the bristles of cattle.

Work in the refrigerating plants of slaughterhouses and packing houses exposes the workmen to some risks from cold. Carrying frozen carcasses over the shoulder has produced frost-bite with resulting deformity of the ear.

The departments in which meats are cooked for canning and animal débris is boiled, etc., present the risk of burns and scalds. (See Canning and Food Preserving Industries.)

A danger to which stockyard men are subject is trauma from the hoofs and horns of frightened animals.

In the meat industry strong antiseptics are used which are capable of producing contact dermatitis among those who clean the work rooms, instruments, and machinery. (See Chemicals and Acids.)

BUTTON MANUFACTURING

This industry has always been considered dangerous due to the dust which is created by most of the operations. The dust from ivory and horn, for example, is composed of sharp angular particles and that from mother-of-pearl contains a large amount of calcium carbonate. The incidence of pulmonary tuberculosis among button makers is more than twice that of the general population, and other respiratory diseases are also very common.

Even with the best of modern devices for dust removal, inspection of a sawing department for pearl buttons showed the walls, machines, clothing, and exposed skin of the workers to be covered with a film of fine dust.

A peculiar inflammation of the bones described by Englisch in 1869 especially among young workers, has been observed occasionally since that time among mother-of-pearl workers. In 1928 a case was reported by Bernstein which consisted of periostitis of the lower jaw and the metatarsus. Although the etiology of this disease has not been satisfactorily determined, it is generally attributed to the absorption of some of the constituents of the shell dust which affect the bones by embolism. It does not seem to occur in factories where grinding of mother-of-pearl is done by the wet process.

Various lesions of the skin among button makers have been reported in the literature. In 1903 Barres and Courtois-Suffit described redness, swelling, and vesiculation around the nails which they believed to be due to the dust produced in the course of "pressing" mother-of-pearl buttons. Koelsch has observed frequent callosities, rhagades, and ulcers of the hands as well as inflammation of the throat.

It is estimated that 60 per cent of all the buttons produced in the United States are made from mother-of-pearl. Other materials are bone, horn, ivory, vegetable ivory, wood, brass, iron, gold, silver, glass, porcelain, paper, celluloid, and various compositions. Of these substances, mother-of-pearl, bone, and vegetable ivory are of the greatest industrial importance.

Mother-of-pearl is prepared by cooking to remove all fleshy matter, and is then sorted and soaked in water for several days. For making flat buttons, the material is cut into rounds, then worked on a lathe, and drilled by a boring machine. The buttons are again steeped in water and treated with hydrogen peroxide. They are finished by polishing with sawdust and stearine.

Bone is generally boiled before it comes to the factory, but still retains its characteristically offensive odor. It is cleaned and bleached with hydrogen peroxide, then sorted and cut into strips with a circular saw, worked on a lathe, and polished in a drum.

In 1907, De Marbaix described a cutaneous affection which occurred in an Antwerp factory and has become known as "bone button-maker's disease." It consisted of inflammation of the fingers followed by suppuration. All the workers were affected, but appeared to become immune after the first attack.

Makers of bone buttons suffer constantly from cuts, scratches, and sores on the fingers caused either by the machines or by the sharp, ragged edges of bone fragments, and the organic dust always present in the air infects the wounds and produces the suppurative dermatitis described.

These workers also run some risk of anthrax and other infectious diseases from the bones and horny material (usually hoofs) of infected animals even under modern factory conditions.

In 1933, Lawson and Stinnett reported cases of erysipeloid in a Virginia factory. The affection became apparent on the third or fourth day and lasted from two to three weeks. The inflammation spread gradually from the point of infection until it covered the greater part of the hand.

Vegetable ivory, also known as African ivory or corozo nut, is the seed of the ivory palm, *Phytelephas macrocarpa*. The nuts are cleaned in a revolving drum to remove the dust and shells, and are then passed to a circular saw, shaped on a lathe, and afterwards put into another drum for "pounding." They are bleached with hydrogen peroxide and polished with sawdust. The dust and waste are used for fertilizer, and the shells for making combustibles. Beads and buttons made from the nut are often engine-turned. These operations are very dusty and should be carried out under an exhaust hood. Vegetable ivory takes dyeing well, thus creating an additional skin hazard according to the dyes used.

Metallic buttons are made on pressing, punching, and stamping machines. The special risk of dermatitis in this case arises from the scouring and polishing materials such as denatured alcohol, benzine, putty powder, Vienna chalk, etc. (See the various metals.)

Almost all of the above-mentioned operations are nowadays carried out automatically. Nevertheless, some skilled workers are still required for certain processes, especially in the manufacture of pearl buttons. Work at the machines involves a number of rapid movements, limited in range, which lead to fatigue of certain muscles and the possibility of tenosynovitis. For instance, Frois has observed a woman operating a small lathe and turning out about 1 700 buttons per hour. Each button requires three small simultaneous movements of the right foot, right hand, and left hand respectively.

CABINET MAKER AND CARPENTER

These handlers of woods sometimes develop allergic dermatitis from poisonous woods which they use. (See Plants and Woods.)

The glues, especially those made of synthetic resins, are frequently a cause of dermatitis. (See Synthetic Resins.)

FIG. 115.—Carpenter: dermatitis from solvents and polishes.

The oils and solvents used in polishing wood may cause dermatitis. (Fig. 115.) Some nails are coated with rosin and asphalt so as to make them difficult to remove. Workers with such nails have developed dermatitis from sensitivity to the rosin.

The hands and forearms of carpenters and cabinet makers are usually affected, but where irritant wood dust is present the face is often affected. Covered parts of the body and sites of friction

such as the belt line and neck may be affected from dust soiled clothing

When wood-workers handle irritant woods such as mahogany Brazilian walnut coca bola, etc they should take cleansing showers after work and have a daily change of clean work clothes.

Most of the dermatitis from poisonous woods is acute and resembles that from poison ivy The treatment is similar to that for ivy poisoning (See Plants and Woods.)

CABLE SPLICER AND ASSEMBLER

Cable splicers may develop allergic dermatitis from the dyes in the paper insulation. Chloracne from wire insulated with the waxy chloronaphthalenes and diphenyls is not uncommon Cable splicers usually work in man-holes the holds of ships and other closely confined ill-ventilated spaces and cannot very well avoid contact with irritants on or coming off the cables. Prevention consists of protective ointments of the lanolin type on the face impervious sleeves and aprons to prevent soiling of clothes, cleansing showers after work and daily change to clean work clothes

CANDY MANUFACTURE

Chocolate is made by roasting hulling and grinding the chocolate bean The ground bean is passed through roller presses which liquefy it. Sugar powdered milk and other ingredients are then mixed with it. Some of the ground chocolate is passed through hydraulic filter presses which press out the oil to make cocoa butter The portion remaining after this process is the powder called cocoa Cocoa butter is often used to enrich ordinary chocolate. The liquid chocolate as it comes from the roller presses is poured into molds which are placed in a cooled room called the "ice box" and there solidified

When bonbons, creams, nuts, fruits, and other centers are to be covered with chocolate they are dipped into a batch of semisolid chocolate and then cooled and solidified in a cooling room The dipping is done either by hand or by machinery In the hand dipping process the girl grasps the center between the fingers and whirls it through a batch of semisolid chocolate until there is sufficient coating on it. The coated centers are then placed on trays and solidified in the cooling room The finished chocolate-covered candy is placed on a traveling belt around which the girls work. These girls sort and place the chocolate into paper containers and then into suitable sized boxes.

Hard candies are made by boiling sugar and water or glucose and water and kneading and pulling the resultant mass either by hand or by machine, in order to swell it and make it white by mixing air with it. Flavors usually consisting of essential oils and vegetable coloring matters are also added Shaping and cutting the hard candy is done over gas flames

There is no skin hazard from dust in this industry. The only dust present is from starch in the starch room where the centers are made. No cases of dermatitis were found due to this cause.

Girls placing candy in small papers and in silver foil have the skin on the ends of the fingers and around the roots of the nails cut in many places from the paper and from the foil and these cuts sometimes become infected. Many of the girls doing this work wear strips of adhesive tape wound around their fingers to prevent cutting by the foil or paper. They prefer the adhesive tape to wearing gloves.

Girls who tie boxes of candy with cord and ribbons have cuts and callouses on their hands and fingers from the cord.

Among the makers of hard candy, particularly among those who work with hot candy and over gas jets, burns of the hands and arms are common. They are usually of minor importance and necessitate no lay-off from work. Occasionally a severe burn occurs and sometimes a minor burn may become infected.

FIG. 116.—Cinnamon oil dermatitis. Candy maker.

Men mixing and handling granulated sugar used in hard candies often show a dry, hard and fissured condition of the skin of the palms and dorsum of the hands, accompanied by inflammation of the skin at the root of the nails and desquamation of the skin of the fingers. This is probably the most frequent type of occupational skin disease found among candy makers. In a group of 187 cases of dermatitis attributed to sugar in England in one year 93 were among confectioners.

There is occasionally found among the hard candy makers a worker who is sensitive to one or more of the essential oils used

in flavoring The most common of these oils are the oil of cassia which is distilled from cinnamon bark, oil of peppermint, oil of orange peel oil of lemon peel, oil of anise oil of cloves and oil of birch Extract of vanilla natural and synthetic, is also used a great deal for flavoring Dermatitis resulting from sensitivity to these flavoring agents usually consists of pruritus, erythema papules, vesicles and crusts. Workers so affected should be removed from contact with these irritants. (Fig 116.)

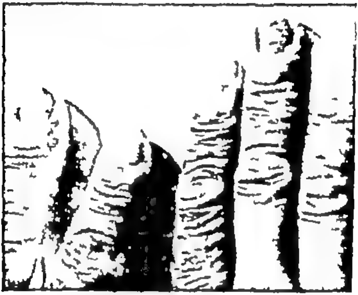

Fig. 117 —Paronychia and erosion of nails of grape-fruit sectioner "

Citric acid and tartaric acid are used in mixtures with sugar in the manufacture of certain hard candies. These acids in the presence of moisture have the action of splitting sucrose into invert sugars of which levulose is extremely hydroscopic and has a dehydrating action on the skin Workers who are required to hand mix batches of granulated or powdered sugar with these acids and whose hands perspire may develop dry cracking eczemas and sometimes secondary infection.

Dermatitis is also occasionally seen among chocolate dippers where there is a sensitivity to a particular brand of chocolate. In one such case there was a positive patch test reaction to a variety of chocolate known as "home made chocolate which was made by the Dutch process in which the ground nuts are roasted and then sprinkled with potassium carbonate and allowed to stand for a period of from twenty-four to forty-eight hours. The nuts ferment during this period and then they are roasted About [illegible] pounds of potassium carbonate to 100 pounds of chocolate are used in this

process and the sensitivity may be due to the alkaline potassium carbonate.

Workers employed in shelling nuts and cutting fruit have their hands immersed in water and are also exposed to the action of the juices of the nuts and fruit. Occasionally a worker is found who will develop a dermatitis from such causes. Pineapple and the citrus fruits are the principal ones which cause dermatitis among candy makers. (Fig 117)

Sensitivity to cashew nuts has also been reported.

Oppenheim reports a case of dermatitis among candy workers manufacturing ice lollypops in which calcium chloride used in manufacturing the ice was the causative agent.

CANNING AND FOOD PRESERVING

Occupational dermatitis has been reported as occurring in almost every one of the food industries including meat, fish pastry candy fruit and vegetables.

Meat.—In meat packing occupational dermatitis usually occurs from handling the carcasses of diseased cattle.

In slaughter houses erysipeloid is not of infrequent occurrence among those handling the carcasses of diseased swine. It is caused by infection with the bacillus of swine erysipelas.

"Hog Itch" is another occupational disease occurring among those who handle the intestines of hogs infected with roundworms. It is caused by a sensitization to the secretions of the roundworms.

A peculiar erosion of the nails is seen among workers extracting the pancreas or sweetbread from the carcasses. This is caused by the digestive action of the pancreatic enzyme on the nails. The nails are eroded and have a moth-eaten appearance. They soon regenerate after contact with pancreatic juice ceases

An atypical form of variola can be contracted from sheep suffering with sheep pox.

Butcher's pemphigus, an acute febrile disease following cuts or abrasions, is a rare disease.

Other diseases of rather infrequent occurrence occurring in those who handle meat, are anthrax, brucella eruption foot-and-mouth disease, actinomycosis tularemia from rabbits, and verruca necrogenica contracted from handling tuberculous cattle.

Fish.—Occupational dermatitis is quite frequent among fishermen It is known among them as 'fish poisoning' This term covers a multitude of conditions

1 Erysipeloid which results usually from puncture wounds of the hand inflicted by the sharp fins and bones of red fish. The Rose fish a variety of rock cod is the fish causing most erysipeloid in Massachusetts.

2. Red feed poisoning Dermatitis occurs in the handling of mackerel and is caused principally by remains in the stomach of a small crustacean known as "red feed." The acid juices of the mack-

erel's stomach are so strong when it contains red feed that after the mackerel is dead the juices will eat through not only the walls of the stomach but even through the flesh of the mackerel itself Red feed dermatitis is caused by these strongly acid juices

3 Durry poisoning There are other infections of the skin of fishermen all classified under the name of "Durry Poisoning" Durry is the name given to all those parts of the fish which are not used for food i e the scales, the intestines the head the tail and the fins.

4 Pigeon is the name given to an infection occurring around the wrists or necks of fishermen It is caused by friction of the sleeves or collars of the rubber coat with subsequent infection.

In salting and curing fish dermatitis may occur from salt and brine

Fishermen are also subject to bites from venomous fish such as the dogfish catfish etc

Contact with salt mustard and vinegar used as condiments for meats and fish or as preservatives for various foods, may give rise to painful sores.

Workers in canneries who prepare mushrooms are subject to keratitis lachrymation and other ocular affections accompanied by such constitutional symptoms as vomiting and jaundice Helvellic acid which becomes vaporized in the air when the mushrooms are washed in cold water is believed to be the cause

Milk.—Workers in dairies sometimes develop a condition known as "milk nodes" which are callosities on the fingers and palms of the hands due to milking Milker's warts which may be due to handling tuberculous udders also occasionally occur among dairy workers.

While no dermatitis had been reported from milk itself dermatitis does occur among workers who handle cheese It is due to a small maggot *Tyroglyphus longior* This condition affects the hands, the forearms, and interdigital spaces.

Fruits.—Dermatitis occurs among people picking and packing fresh fruit as well as among those canning fruit.

In the citrus fruit industry dermatitis occurs from the irritant oil in the rind of lemons, oranges, limes and grapefruit (Fig 118) The chief ingredient of this oil is limonene Among those who pick citrus fruit dermatitis may occur from the thorns on citrus trees and from the insecticides and fungicides sprayed on the trees. Paronychia is not uncommon among the canners of citrus and other fruit.

Peaches have often caused dermatitis both among those who pick them because of the sharp fuzz on many varieties and on those who can them The canners develop dermatitis from the juice of the peach which contains much sugar and is hydroscopic and irritating to the skin

Dermatitis has been reported from the cyanide insecticides used on grapes.

The milky sap from the stem of the fig causes a photosensitization dermatitis.

Those peeling the pineapple often develop dermatitis from the sharp spears on the pineapple as well as from the high content of sugar in the juice.

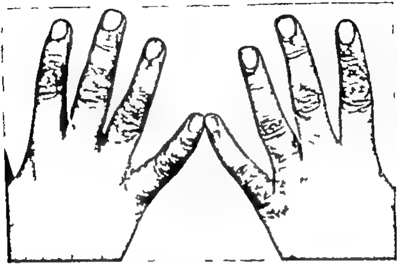

FIG. 118.—Occupational dermatitis in a salad girl brought on by handling lemon orange, grapefruit and pineapple, also by drinking lemonade. (Case of Dr B. M Kesten, Vanderbilt Clinic, Columbia University New York.)

Dried Fruits.—Dermatitis occurs from dried fruits and is often the cause of Grocer's Itch. Dried dates, prunes, figs, apples, and pears, sometimes are infested with mites known as *Carpoglyphus passularium* and *Glycyphagus domesticus*

Tea leaves sometimes are infested with a mite known as *Rhizoglyphus parasiticus* and wheat may contain a mite known as *Aleurobius farinæ*

Nuts.—Dermatitis has been reported among those handling dried coconuts or copra. Copra is sometimes infested by a large beetle which irritates the skin of workers loading and unloading it from ships.

Brazilian nuts have been reported to cause dermatitis and so has peanut oil.

Vegetables.—Dermatitis occurs in the handling and canning of practically all kinds of vegetables.

Workers picking lettuce are said to develop dermatitis from the milky sap coming from the cut of the lettuce.

Artichokes, carrots, celery corn garlic, mint parsley parsnips potatoes, and tomatoes, have all been reported as having caused occupational dermatitis, especially in canneries where these vegetables are peeled cut, dried, and where their juices have an oppor

tunity to stay in contact with the skin for a considerable length of time

Bread and Cake.—Dermatitis occurs among the makers and handlers of flour. Allergy may be developed towards the bleaches and persulphates used to bleach the flour. Most of such cases have been reported from Europe. A few cases of dermatitis have been reported from allergy to the wheat itself.

Dermatitis has been reported from the flavoring agents used in cakes. Cinnamon and vanilla have been the chief offenders.

Pickling.—In making pickles many irritant substances are used. Acetic acid, strong brine, pepper, are some of these. In the fermentation of pickling, lactic acid is formed and this can cause dermatitis even in dilute solutions.

The sugar used in making sweet pickles may dehydrate the skin.

FIG. 110.—Protective clothing for canneries.

In addition to dermatitis from the articles of food themselves, dermatitis has occurred from the resin lining of certain types of tin cans. The ordinary tin lining of a tin can discolors some types of foods such as maraschino cherries, and therefore the cans used for holding such substances are lined with a resin lining. The workers handling the cans come in contact with flakes of resin coming off the lining and may develop a sensitization dermatitis.

Prevention.—The prevention of dermatitis in the food industry is very simple. It consists of food handlers wearing rubber gloves (Fig. 110), impervious sleeves fastened over the gloves at the wrists, and impervious aprons. Not only does this type of protective clothing protect the worker from contact with the materials which are handled but it also protects the materials from contamination.

Protective clothing of this type should be furnished to all food handlers. It should be furnished clean to them daily and should be kept in repair by the management.

CARPET AND RUG MANUFACTURE

Modern carpet manufacture involves the use of machinery for practically all the operations and manipulation of many different kinds of materials.

Woolen and worsted yarns are generally used for the surface of the carpet, and cotton linen, jute, and hemp for the back. Jute and hemp are employed in considerable quantities as fillers to give body and weight, and also as a weft in Axminsters. Cotton is much used for chain warps and forms the weft of Wilton and Brussels carpets. Flax is sometimes used as a weft yarn in Brussels carpets and tapestry Other materials which occasionally enter into the manufacture of carpets are mohair cowhair and horsehair for the surface, and ramie for the back.

The yarns are impregnated with oil and grease received during the process of spinning and must be washed with soap and hot water before they are dried. While still damp the yarn is passed into the dyeing machines.

Oriental rugs are made by hand and dyed usually with aniline or alizarine dyes. Many Oriental carpets and rugs are subjected to washing or faking" in order to soften the colors and make them look old. Chlorine or acetic acid is used to give the faded effect, while glycerine and ironing produce the desired gloss. Sizing is done with a mixture of glue and starch

In making certain kinds of carpets such as Brussels, the worsted threads are looped over wires. In some factories the raw materials are sorted carded, twisted and woven in others, they come in bales already prepared for weaving On arrival the bales are opened and the dust removed in dusting machines.

After being woven ordinary factory made carpets are sheared to equalize the length of the threads and are then brushed to raise the pile. Beating is generally done in a closed beating machine. Some types of carpets are dry-cleaned with suitable solvents.

Opening the bales of thread removing the dust, shearing, brushing and beating are very dusty operations which produce the same constitutional and cutaneous effects as in other textile industries. (See Textiles, Wool Hemp Jute, Cotton, etc.) The irritating action of the dust is intensified by the presence of dyeing materials. Aniline colors have largely replaced chrome and lead and the use of arsenical dyes has been greatly reduced if not abolished in many countries, diminishing the hazard from this source. Aniline dyes may however produce dermatitis in certain individuals, and cases of eczema may occur from contact with alizarine.

Chlorine used in the bleaching or fading process may produce a

tunity to stay in contact with the skin for a considerable length of time.

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The sugar used in making sweet pickles may dehydrate the skin.

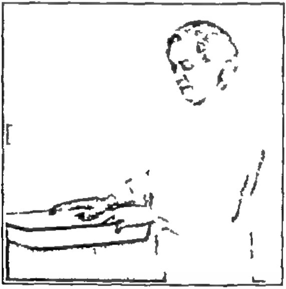

Fig. 119.—Protective clothing for canneries.

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Chemical necrosis of the fingers has occurred due to penetration of the tissues by particles of aniline in colored pencils. This lesion was first described in 1920 by Erdheim of Vienna, and during seven subsequent years no less than 60 cases were reported. After the substance was embedded in the skin for some time, the site became painful and edematous, but without inflammation. This was followed by the formation of a fistula discharging serum. It was necessary to remove the offending particle promptly by surgery to avoid necrotic destruction of the entire finger and the possibility of severe systemic poisoning.

Erythema ab igne may occur on any part of the skin exposed to excessive heat. In the experience of the authors, however, this affection has been observed most frequently among stenographers and office workers with weak circulation who work in poorly heated rooms and press close to the radiator in cold weather.

Contact with glue may cause irritation of the skin, and the practice of licking stamps and envelope flaps which is still done in offices lacking modern equipment may cause ulceration of the tongue and oral mucous membrane.

Although rare, dermatitis has occurred from handling carbon paper and typewriter ribbon, and also from the dust of dictaphone cylinders.

Dermatitis from mucilage on the backs of stamps and envelopes has occurred. It was caused by hypersensitivity to dextrin contained in the mucilage.

DAIRY WORKERS

Modern sanitation and the substitution of machinery for hand labor in the larger plants have greatly reduced the occupational risks in this country. Nevertheless, there still remain many dairies in which these safeguards have not been instituted, milking is done by hand, and the workers are required to care for the animals. These contacts subject employees to various cutaneous affections.

Infectious diseases such as foot-and-mouth disease, noma, brucella eruption, botryomycosis, bovine tuberculosis, milker's warts, vaccinia, trichorrhexis nodosa, actinomycosis, and trichophytosis may be caught from cattle. (See chapters on Bacterial and Mycotic Infections.)

Vaccinia has been comparatively rare since vaccination has become general, but milkers occasionally develop milker's warts from handling the udders of infected animals.

Aspergillosis is not uncommon among cattle and may be transmitted to the workers. In man *Aspergillus fumigatus* affects the respiratory tract and *Aspergillus niger* attacks the ear, producing a mycosis of the auditory meatus and sometimes of the tympanic membrane. Molds in damp straw used for bedding may cause irritation of the skin. Mites such as *Pediculoides ventricosus* in fodder and straw cause an itching dermatitis among workmen who tend the animals.

Myiasis may be contracted from cows and dairymen's itch due to sarcoptic mange of cattle may occur but is said to be rare.

Milkers sometimes develop primrose rash from handling the udders of cows who have come in contact with primroses wet with dew.

Cheese worker's itch is due to *Piophila casei* a maggot that lays its eggs in cheeses and on the fermentation residue. The larvæ are found in the interdigital webs and on the dorsum of the hand and the forearm where they produce punctiform and linear lesions with a pigmented base and elevated hyperemic edges. Since the pruritus is intense the condition is aggravated by scratching. The disease affects particularly the cheese-makers who handle milk.

In dairies where the work is done by hand milkmen sometimes develop large smooth callosities on the palms. Often the skin cracks and become deeply fissured so that constant irritation from the cow's hairs may result in deep infections.

Milker's nodes are nodular inflammatory lesions occurring on the hands of milkers stockmen and others handling the udders of cattle. It is transmitted from cow to man and man to man. While most of the cases have been reported from Europe some have been reported in the United States.

The disease disappears in a few weeks without treatment. Those who handle vesiculated udders will after a few days develop papules on the hands. The papules grow into hemispherical reddish tender nodules.

There are little if any systemic symptoms.

Prevention consists in the wearing of rubber gloves when handling udders.

Deliverymen may develop keratotic pressure pads on the sides of the fingers from carrying several bottles together between the fingers. The authors have observed a case of this kind.

Strong solutions of borax and other alkaline substances used for cleaning milk bottles are capable of causing dermatitis.

DISINFECTANTS AND FUMIGANTS

Disinfection may be carried out by solutions, powders, or vapors. Most of the ingredients used in their preparation are strong skin irritants.

A few examples of the substances and manufacturing processes used illustrate the many cutaneous risks incident to this work.

Ingredients	*Process*
Creosote Powdered rosin Caustic soda lye Methylated spirits Black treacle Boiling water	The rosin is melted and the creosote, lye, methylated spirits, and treacle are added consecutively. The whole is then boiled until all the substances are dissolved.

Ingredients	*Process*
Yellow soap shavings Gas tar Soda	The soda is dissolved in water and the soap in the tar and the two solutions are then combined without heat.
Rosin Caustic soda lye Black tar oil Nitro-naphthalene	The rosin is melted and the lye added to it. Next the tar oil is stirred in, followed by the nitronaphthalene which has been dissolved in boiling water
Black powdered rosin Sulphuric acid Creosote Melted pitch Perlash boiled in water	The rosin and acid are dissolved in boiling water the creosote added and the solution boiled again Then the pitch and boiling perlash are put in
Alum Sodium carbonate Ammonium chloride Zinc chloride Sodium chloride Hydrochloric acid	The alum is dissolved in boiling water and the other ingredients added separately
Mercuric chloride Cupric sulphate Zinc sulphate Sodium chloride	All the ingredients are dissolved together in water

Powders may contain iron sulphate, zinc sulphate, powdered oak bark tar and oil or calcium chloride mixed with burnt umber made into a paste with water and dried. A carbolic powder contains carbolic acid and slaked lime and is colored with an aniline dye. Some powders contain red lead with alum green copperas carbolic acid spirits of turpentine and slaked lime.

Formaldehyde can be used in solution or as a vapor for disinfecting purposes. For the fumigation of rooms, books, paper etc. it is generally combined with pastilles of trioxymethylene. (See Chemicals.) The effect of strong solutions of formaldehyde on the skin is to coagulate the protein and produce necrosis and scarring Prolonged contact with weak solutions causes eczematous lesions with vesicles, rhagades, and ulceration. The nails become brownish soft, and necrotic with inflammation of the grooves and suppuration of the matrix. Irritation of the mucous membranes of the eyes, nose and throat also occurs.

Many fumigants contain potassium nitrate charcoal mastic phenol and aromatic ingredients such as styrax, balsam of Peru vanilla, sandalwood oil of bergamot and other essential oils that are potential irritants to sensitive skins. (See Cosmetics.)

The skin irritants encountered in the manufacture and use of disinfectants are so numerous that for convenience they are listed below For further descriptions of the various substances reference

may be made to the chapters on Alkalis Insecticides and Fungicides and Chemicals.

Acetaldehyde	Methylated spirits
Alum	Mercury chloride
Aluminum chloride	Nitronaphthalene
Ammonia	Phenol
Aniline colors	Picric acid (see Explosives)
Bromine	Pitch
Calcium chloride	Rosin
Chlorine	Sodium carbonate
Cresol	Sulphur dioxide
Creosote	Sulphuric acid
Essential oils	Tannin
Formaldehyde	Tar and tar oil
Hydrochloric acid	Turpentine
Hydrocyanic acid	Zinc chloride (see Zinc)
Lead	Zinc sulphate (see Zinc)

DOCK LABORERS (LONGSHOREMEN) AND WAREHOUSEMEN

Loading and unloading ships necessitates the transportation of heavy loads between dock and boat and to and from trucks freight cars, and warehouses The work of the dock laborer includes weighing measuring and packing the goods which arrive in bulk, barrels, boxes bales, or packages. Although mechanical loading apparatus is used the men must load these receptacles by hand except in the case of automatic hods. Minerals often arrive in a cohesive mass that must be broken up with pickaxe or crowbar and some have to be handled in a heated state

The labor is unskilled muscular strength being the chief requirement. Heavy burdens are carried on the shoulders and back against the abdomen or loins or in any way that seems best adapted to the nature of the load. In Europe women often help to open and repair burst sacks, shovel spilled material beat and brush hides and so on

The incidence of hernia muscular affections and accidents is high in this occupation

The workers may contract contagious diseases from contaminated water infected goods bites of insects, or the excreta of diseased persons on board ships. They are usually the first to catch yellow fever plague cholera, etc. which later become epidemic.

Diseases of the skin are prevalent. The men work in all kinds of weather and are subject to the dermatoses caused by heat and cold *e g* frost-bite chilblains, sunburn miliaria etc Wounds, callosities, and chafing of the skin from tools and burdens occur frequently (See chapter on Physical and Mechanical Agents.)

Pigmentation, hypertrophy or atrophy of the skin may result from friction of loads and callosities frequently develop on the shoulders. Pseudo-edema of the shoulder has been observed among dock workers who unload coal and gummata may occur at the point of friction among syphilitics.

Badly constructed handles of trolleys and tilting trucks cause callosities and blisters which become infected These lesions occur on the hands of workmen even when gloves are worn. The men are often equipped with protective pads between the shoulder blades and down the back to lessen friction and pressure of the loads. The pads themselves weigh from 6 to 8 pounds and may cause skin irritation particularly in warm weather

Irritating and poisonous dusts from such cargoes as grain minerals, coal and chemicals, mingled with the sweat on the skin cause many cases of dermatitis. Dust from grain contains hairs, sharp spikes, particles of vegetable matter earth and minerals which irritate the respiratory mucosa and skin. Great quantities of dust are raised by grain elevators equipped with hoppers and by the process of weighing The dust increases with every process. In addition, acari and spores of fungi in the dust produce a variety of dermatoses. (See Chapters on Animal Parasites and Mycotic Infections.)

Roasted minerals are a source of poisonous dusts, though in some cases they are dampened before being unloaded The lead manganese, arsenic, and silica content of many substances is a source of danger At Antwerp manganese minerals from India which often contain 12 to 16 per cent of silica are considered among the most dusty and dangerous of cargoes. Calamine from Malfidane is also irritating due to the high percentage of lime it usually contains. Other sources of irritation are coal dust cement, basic slag guano and other artificial fertilizers. Chemicals packed in boxes etc. often erode the coverings or break through the containers and create harmful dusts.

Fumes from tank ships which carry mineral oils or other irritating liquids, despite automatic unloading may cause poisoning Gases such as phosphoretted hydrogen from cargoes of ferrosilicon hydrocyanic acid and sulphur anhydride used to fumigate ships may affect the laborers. Deaths have been reported from the accumulation of such gases in the ship s hold

Dermatoses due to materials handled by longshoremen are practically unlimited and only a few will be mentioned here. The following cases have either been reported in the literature or observed by the authors

Anthrax from carded wool and felt, and from hides and skins.

Acariasis often epidemic from unloading grain infected by parasites chiefly *Pediculoides ventricosus* Lesions on the sides of the neck occur from carrying sacks of grain such as rice barley etc. Acariasis has also been reported from shoveling figs and from unloading coconuts (copra itch) Used sacks may be covered with mites even when they are empty (See chapter on Insects and Animal Parasites.)

Mycoses from molds and fungi in vegetable matter Urticarial itch has been reported from unloading logs infected with fungi. (See Mycotic Infections.)

Gangrenous dermatitis of the fingers and shoulders of men who unload hydroxides of iron

Toxic bullous lichenoid melanodermatitis caused by handling tar

Inflammation of the ear followed by otorrhea among workmen who unload coal (especially in the form of briquettes)

Pruritus, skin ulcers, blepharitis and conjunctivitis from sulphur and pyrites.

Blepharitis and conjunctivitis from unloading guano

Septicemia incurred through traumatic injuries while unloading iron ore

Dermatitis and infection from the bites, stings, or pricks of poisonous fish (See Fish Industry.)

It may be observed that warehousemen are subject to many of the risks encountered by longshoremen with the exception of excessive exposure to the weather

DOLLS TOYS AND ADVERTISING NOVELTIES

The doll and toy industry is a comparatively small one in which working conditions are less standardized than in most of the larger modern industries. The labor is seasonal and hand work is still the rule

The dolls and toys made in shops are of the stuffed variety, the hard parts being made of an unbreakable composition and the soft parts of cotton or other fabric stuffed with cotton, excelsior or kapok. Straw and sawdust are seldom employed in this particular type of toy

The composition used for the foundation is a mixture of rosin starch and glue. This is placed in a mold over a gas flame and baked until hard. The form is then taken out and dipped by hand into a solution of white lead. In this operation the hands come in contact with the lead, yet within the past five years, no cases of lead poisoning have been reported in New York City. After the lead dip the dolls are finished with a coat of lacquer or enamel

In the workshops there is a lack of proper ventilation and the workers suffer considerable discomfort from the fumes of various solvents of lacquers and enamels particularly amyl acetate

Although statistics are lacking concerning the incidence of dermatitis among these workers, it is obvious that sources of risk are very numerous, especially in view of the many hand operations and poor ventilation. These may be listed as follows

Rosin	Enamel
Glue	Aniline colors
Lead	Excelsior
Lacquer	Amyl acetate and other solvents

(See the various subjects for specific effects on the skin.)

Other dolls are often made of china, metal or celluloid for the hard parts with straw or sawdust for stuffing. The manufacture of such articles exposes the workmen to the risks inherent in pottery

making metal working and the manipulation of pyroxylin and straw (*q v*)

In the manufacture of toys and advertising novelties in general the number and diversity of substances handled are so great as to make it impossible to do more than suggest them here. For example a lead-tin alloy containing from 40 to 90 per cent of lead is widely used in the manufacture of small toys. Wood iron copper nickel bronze paper bakelite, catalin, leather (genuine and artificial) fur glass, china rubber bone shell etc. enter into the composition of these articles. Manipulation of the materials includes wood turning metal cutting stamping and scouring molding soldering painting varnishing enameling glueing etc.

DRUGS THAT MAY CAUSE DERMATITIS

Many of the chemicals used externally are known primary irritants. These are the caustics, styptics, fungicides, rubefacients, etc. The effects of such irritants depend upon the concentration of the drug and the length of time it is in contact with the skin Most of the therapeutic agents used externally are not primary irritants in the concentrations in which they are used. However a sensitivity to them may be acquired by some individuals usually after prolonged contact In some instances, the incubation period for the development of a sensitivity may be relatively short, i e seven to ten days. This depends on the chemical nature of the drug whether it is used on broken or unbroken skin the area of skin treated and other factors.

As a general rule the skin eruptions which are seen following internal administration of a drug are of the so-called toxic type The eruptions may be urticarial they may resemble erythema multiforme they may be scarlatiniform or morbilliform in character Drugs such as phenolphthalein and amidopyrine atabrine and others may cause fixed drug eruptions. Skin tests, patch scratch or intradermal with the offending drug do not as a rule give positive reactions except in some of the urticarial type of eruptions where scratch and intradermal tests as well as the Prausnitz Kustner reaction may be positive In most cases of drug eruptions, the diagnosis can only be made by a careful history or by the reëlicitation of the eruption by administration of the drug causing the eruption

Sensitization dermatitis produced by external application of a drug is nearly always of the eczematoid type Once sensitization of this type has been established even internal administration of the same drug will give rise to an eczematoid dermatitis. Eczematoid eruptions following intravenous injections are due to the sensitization of the skin produced by contact of the drug with the skin as the needle is being inserted or by paravenous injections. Absorption of a drug can also occur through the skin and give rise to widespread eczematoid eruptions in those previously exhibiting an allergic con-

tact dermatitis In the eczematoid type of drug eruption the diagnosis can usually be established by means of the patch test

The problem of dermatitis in the manufacture of drugs differs from that arising from their use in that many of the intermediates used in their manufacture are both primary irritants and sensitizers. Also the workers have much more continuous contact with the drugs over a longer period of time and in greater concentrations than the users Prolonged contacts with the finished products are also encountered among pharmacists.

Many of the drugs that are capable of producing a contact dermatitis have been described under the following general subject to which the reader may refer

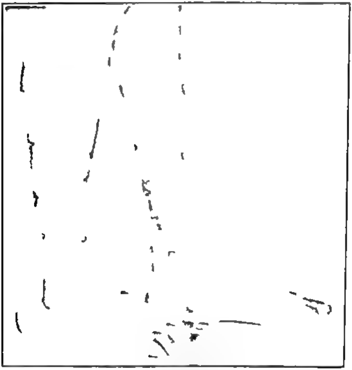

FIG. 190 — Atabrine dermatitis Hyperkeratotic lesions of leg Present few lesions of buccal mucous membrane

Chemicals Which Are Known to be or Which Can be Skin Irritants
Inorganic and Organic Acids
Alkalis
Dermatitis From Plants and
Cosmetics
Medical and Allied Profess ists and Pharmaceutical Chemists)
ication of Causes (A

We wish to mention briefly some of the newer drugs which may cause dermatitis both in their manufacture and in their therapeutic use.

Atabrine.—Atabrine (quinacrine hydrochloride) is made by reacting novol diamine (1 diethyl amino 4 amino pentane) with halocrin (2 methoxy 6 9 dichlor acridine) in the presence of liquid phenol.

Among the chemicals used in the manufacture of atabrine phosphorous oxychloride, thionyl chloride and dichlorbenzoic acid are primary irritants. Among the intermediates formed in the process of making the finished product, novol diamine, novol ketone and the novalid salts are primary irritants.

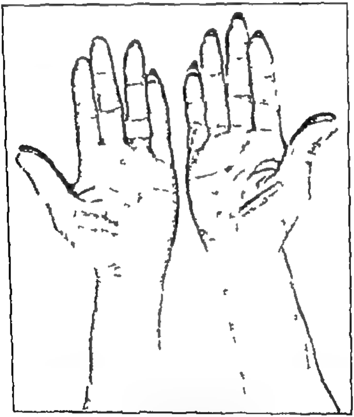

Fig. 121.—Dermatitis from atabrine

Workers manufacturing atabrine may develop irritation of the mucous membranes of the eyes, nose and throat as well as dermatitis. Most of the dermatitis is seen among the workers handling or dumping (a series of recrystallizations to purify the atabrine) the finished product. All of the workers engaged in this last phase of the work develop a yellow staining of their hands from contact with wet atabrine Hardening is seen among the older workers.

Those workers engaged in the manufacture of atabrine who are exposed to the chemicals previously mentioned should wear impervious clothing and hood respirators during exposure periods.

Fig 122.—At owing marked t tion involution of all ked but d y affect the photograph

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of fixed type of eruptions. The involved skin may undergo atrophy and there is usually a great deal of pigment melanin formation. The pigmentation persists for long periods after the drug has been stopped. An unusual feature in addition to the atrophy is that

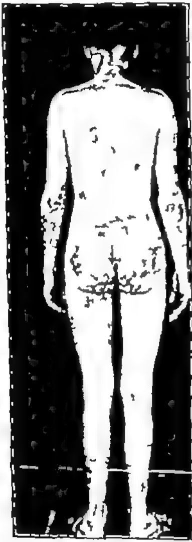

FIG. 123.—Atabrine dermatitis. After exfoliation has subsided showing hypertrophic and hyperkeratotic lesions. Small papules on feet. Lichenoid and chest typical of lichen planus.

positive patch tests have been demonstrated with atabrine in these cases. To our knowledge patients with either the lichenoid or the fixed type of drug eruptions caused by other drugs do not exhibit positive patch tests with the drugs causing the eruptions.

DDT.—DDT (2, 2 bis (p-chlorophenyl) 1, 1, 1 Trichlorethane) has as yet not been reported to have caused dermatitis either in its manufacture or from its use as an insecticide. Experiments to test the irritating properties of this material were made by applying DDT powder to the unbroken skin under a patch test on 108 individuals. There was a 1+ reaction in 6 of the test subjects after twenty four hours and in 4 after seventy two hours. A second series of patch tests with the DDT powder was made ten days after the first series on 160 of the original group who had failed to exhibit any reactions from the first series of patch tests. In three of these individuals there was a 1+ reaction after twenty-four hours. This experiment seems to indicate that DDT may act as a weak primary irritant and sensitizer.

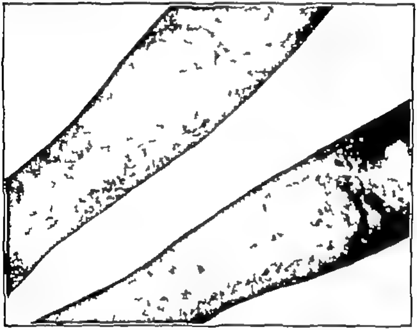

Fig. 124. Dermatitis from contact with emetine hydrochloride.

Chronic toxicity tests on animals have shown that DDT was toxic, that its effect was cumulative and that its principal actions were on the central nervous system and the liver.

Emetine Hydrochloride.—Emetine hydrochloride used in the *treatment of amebic dysentery is a powerful skin sensitizer both* in the powdered form and in solution. It will cause conjunctivitis if dropped into the eye. (Fig. 124.)

Workers handling emetine hydrochloride in powder form should wear impervious clothing and ho[illegible] rators. Workers on the pelleting machines should wear sim[illegible] tive clothing. Workers *filling ampules with the solution* [illegible] *hydrochloride should* wear tr[illegible]rent face shields and [illegible]ves to protect them agai[illegible]s of the solution.

Methyl Bromide.—Methyl bromide is a delousing agent used by the armed forces. It is a volatile liquid boiling at 40° F. As an insecticide it is put into ampules and clothes to be fumigated are put into a gas proof bag with the ampule of methyl bromide. Breaking of the ampule causes rapid volatilization of the liquid and the vapors quickly kill the parasites and their eggs.

Actual wearing tests of clothing fumigated with methyl bromide showed that such clothing was no dermatitis hazard since all of the chemical evaporates shortly after such clothing is exposed to the air.

Girls filling the ampules with methyl bromide not infrequently developed second degree burns of the fingers from contact with the liquid methyl bromide. The burn was due to the actual primary irritation of the liquid methyl bromide plus an action like frost-bite due to the freezing action of the evaporating methyl bromide.

Routine preventive measures such as the wearing of natural and synthetic rubber gloves was of no avail because the liquid methyl bromide readily penetrated these materials. The burns were prevented by having the stopcocks on the filling machines which the girls manipulated to control the filling of the ampules placed at least 12 inches from the outlet.

Penicillin.—Urticaria seems to be the chief if not the only evidence of sensitivity following clinical use of penicillin. With the urticaria chills and fever may be accompanying symptoms. Keefer reported 14 cases of urticaria of 500 cases treated with penicillin and Lyons reported 12 of 209 cases treated.

Most lots of penicillin sodium (1,000 units in 0.1 cc. of water) on intracutaneous inoculations produce in one to two hours areas of edema, erythema and sometimes vesicles. Therefore, most commercial penicillin sodium is a mild primary irritant on intradermal injections (Welch and Rostenberg). Crystalline penicillin has no primary irritating properties when injected intradermally. From this it can be concluded that the irritation is due either to a contaminant or a by-product. The last named authors reported a patient who exhibited a tuberculin type of hypersensitivity to penicillin sodium. This man had had no prior exposure to penicillin however he has had intermittent contact with molds over a period of years.

Further studies by Rostenberg and Welch indicate that about 5 per cent of the population is sensitive to penicillin despite the fact that these individuals have had no prior contact with the substance. Since it has been shown by Peck and Hewitt that the dermatophytes including *T. mentagrophytes* the common cause of fungus infection of the feet, can elaborate a factor closely resembling penicillin and since a large percentage of the population at sometime or other have had fungus infection of the feet, this may explain the apparent spontaneous sensitivity to penicillin in our population.

There have been a few reports of dysidrosiform generalized eruptions as well as papular vesicular eruptions on the hands, feet and groin following injections of penicillin. This too seems to indicate that the molds used in the production of penicillin (*P. notatum*)

and those causing fungus infections of the feet and other areas elaborate a common factor to which a sensitivity may be acquired.

Phenol-camphor.—A severe dermatitis may result from the use of phenol-camphor mixtures in the treatment of dermatophytosis. Deep ulcerations of the skin have been encountered from its use.

FIG. 125.—Dr. J. H. T[illegible]ston Davies' patient, J. B. Earliest stage of the condition in [illegible] soldier who had had sulphanilamide powder insufflated into the external auditory meatus for ten days.

Sulphonamides.—The sulphonamide compounds are being extensively used in the form of ointments, powders and lotions for many dermatologic conditions. They are even being added to shaving cream and tape bandages. While toxic manifestations from the internal use of the compound have been frequently reported, it has only recently been recognized that topical applications of the sulphonamides even in small amounts leads to numerous cases of cutaneous reactions especially when used on the broken skin or mucous membranes. (Figs. 125 and 126.) When sensitization from external application of the sulphonamides occurs, it precludes their use at some future time when their administration may be a life saving measure.

Recognizing the dangers of the indiscriminate use of the sulphonamides, many states are prohibiting their sale whether for internal or external use without a prescription.

Vitamins.—In the manufacture of vitamins many intermediates are used and dermatitis is not infrequent especially among those handling nitrochlor compounds. In the manufacture of B6 (pyredoxine) dermatitis was seen from the intermediates.

Dermatitis has been seen from the topical application of cod-liver oil ointments.

Fungicides.—Many new chemicals are being used as *fungicides*. In strong concentrations they may act as primary irritants and

Fig. 126. Dr. J. H. Twiston Davies' patient W. B. Quiescent stage in patient he had relapsed on exposure to strong sunlight three months after the original attack.

Fig. 127. Dermatitis due to application of iodine to a slight chafing from sleeve. Claimed by worker to be due to leather but patch test with leather was negative.

in weaker concentrations as sensitizers. The organic mercurials, especially the phenyl mercuric compounds are particularly prone to cause dermatitis.

In order to avoid redundancy we give below only a partial list which will suggest the wide range of cutaneous irritants that may be encountered in the field of pharmacology.

Acetic acid
Aconite
Acriflavine
Ammonia
Ammonium chloride
Amyl nitrate
Anesthesin
Antimony
Apomol
Apiol
Aristol (thymol iodide)
Arnica
Arsenic
Atabrine
Atropine
Avertin
Balsam of Peru
Barium salts
Belladonna
Benzoic acid
Benzoin
Benzol
Bloodroot
Boric acid
Bromine
Butesin picrate
Butyn
Camphor
Camphorated chloral
Cantharides
Capsicum
Chaulmoogra oil
Chloral hydrat
Chlorine
Chloroform
Chromium trioxide
Chrysarobin
Cinchophen
Citric acid
Cocaine
Codeine
Colchicum
Copper sulphat
Creosot
Croton oil (oleum tigl)
DDT
Delphinium
Digitalis
Emetine hydrochloride
Ephedrine
Epinephrine (adrenalin)
Ergot
Ether
Ethyl alcohol
Ethyl chloride
Fatty acids
Ferric chloride
Flax
Formalin
Glacial acetic acid
Glycerine
Guaiacol
Heroin
Hexylresorcinol (caprokol)
Hormones
Hyoscyamine
Ichthyol (sulphonated bitumen, contains 10 per cent sulphur)
Iodine
Iodides
Iodoform
Iodol
Ipecacuanha
Juniper
Larkspur
Lobelia
Lysol
Menthol
Mercury (mercurochrome, merthiolate, metaphen)
Methyl alcohol
Methyl bromide
Methyl salicylat
Morphine
Mustard
Naphthol
Nicotine
Nitric acid
Nitroglycerine
Novocaine (procaine)
Novol
Nupercaine
Oil of wintergreen (methyl salicylate)
Oil of anise
Oleum tiglii (croton oil)
Orris root
Orthoform
Opium
Paraldehyde
Pennyroyal
Peroxide of hydrogen
Phenol (escharotic)
Physostigmine
Picric acid
Pilocarpine
Podophyllum
Potassium mercuric iodide
Procaine hydrochloride
Pyrogallol
Quinine sulphat
Quebracho (aspidosperma)
Resorcin
Saligenin
Salicylic acid
Sanguinaria
Scarlet red
Silver nitrat
Sodium chloride
Stovaine
Strychnine
Stypticin (cotarnine chloride)
Sulphanilamide and related compound
Sulphur
Tansy
Tartar emetic
Thallium
Thymol (thymic acid)
Trichloracetic acid
Turpentine
Trinitrophenol
Uva ursi
Viburnum
Vitamins
Yohimbine
Zinc sulphate

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DRY-CLEANING INDUSTRY

The removal of stains and dirt from garments and other articles such as carpets draperies slip covers gloves, etc., is carried out as a preliminary operation in dyeing plants and also as a separate industry

It is not a flattering commentary on human nature however that dry-cleaning establishments set apart dark woolen clothing for special treatment due to the excessive amount of dirt allowed to accumulate because of lessened visibility These garments carry a considerable risk of infection to the workmen.

Articles are inspected and sorted on arrival at the factory pockets and cuffs are turned out and brushed and buttons and ornaments that may be injured by the cleaning process are removed Spots are discovered their nature determined and a workman known as a "spotter" sets to work to remove them before the articles go to the drums for general cleansing

Employees who collect sort and inspect wearing apparel, blankets etc are exposed to infections that may be transmitted by handling the articles themselves or by the dust raised in brushing and otherwise manipulating them The dust from work clothes may also be filled with arsenic lead or other poisonous substances according to the wearer s occupation

The spotter however is the most exposed of all the workmen not only through contact with general and special dirt of unlimited range (for example paint ink grease fruit stains blood perspiration sputum exudate from boils and oozing eruptions, etc) but also from the substances he uses to remove the spots. These are numerous and vary according to the character of the dirt. They include glycerine oleic acid glacial acetic acid petroleum ether chloroform hydrofluoric acid oxalic acid denatured alcohol benzene naphthal-gasoline turpentine trichlorethylene carbolic acid *oil of mirbane (nitrobenzene) amyl acetate carbon tetrachloride* strong alkali, benzine soap and ammonia. All are to some degree cutaneous irritants.

After the spots have been removed the articles are placed in a revolving cylinder containing a mechanism that agitates them in the cleansing fluid which generally consists of gasoline benzene or carbon tetrachloride with the addition of benzine soap and other accessory substances. Paraffin oil is added to gasoline or naphtha for cleaning loosely woven garments, and salicylic acid for certain fabrics.

The articles are removed from the drums by hand, and workers so engaged come in contact with the irritating solvents which contain in suspension much of the dirt extracted from the garments. The clothes are then placed in a hydro-extractor that partially removes the solvents and afterward hung up by hand in a drying room in which warm dry air is kept in constant circulation. These operations also bring the workmen in contact with the solvents that still impregnate the material and numerous cases of dermatitis result from this source while the fumes produce headache nausea and vomiting

The employee who looks after the storage tanks, regulates the filling of the cleaning machines, and purifies the solvents for re-use is exposed to dermatitis from leakage and spillage

Hand cleaning is necessary for certain fabrics and for articles that have become delicate through wear In this work the risk of skin disease is probably greater than that encountered in the machine processes.

Practically all the solvents used in dry-cleaning are cutaneous *irritants that produce dermatitis on prolonged* contact and also through exposure to the fumes if the skin is especially sensitive. Sensitivity can also be acquired in some cases, and the worker may be obliged to change his job (See chapter on Solvents.)

Benzene and Stoddard solvent (a heavier distillate of petroleum) produ[illegible] eczema with fissuring of the skin and in some cases

an acute vesicular dermatitis. The fumes cause irritation of the mucous membranes and constitutional symptoms. Carbon tetrachloride which is extensively used especially in better establishments, produces similar cutaneous and systemic reactions also jaundice and ocular disturbances.

Trichlorethylene and perchlorethylene are potential skin irritants. Chloroform may cause a vesicular eruption of the skin.

The irritating properties of turpentine, glacial acetic acid, methyl alcohol, phenol, nitrobenzene, potassium and sodium hydroxide and ammonia are too well known to need recapitulation here.

Some wet processes are carried out in dry-cleaning plants and involve the use of soap suds, soap bark (*Quillaja saponaria*) and potassium or sodium hydroxide or ammonia solutions which are brushed on either by hand or by machinery. Next follows a bath of acetic, hydrochloric, or sulphuric acid. Contamination with some dyes present in the materials may produce dermatitis.

Carpets and rugs are often cleaned with trisodium sulphate added to chips of neutral soap and a small amount of water and then sized with a solution of animal glue, glycerine and zinc sulphate in water. These substances likewise are potential sources of dermatitis.

Furs and gloves are softened before cleaning by treatment with neat's foot oil.

Pressing is done by machines and also by hand irons, and in these operations burns are often incurred both from the hot irons and the steam arising from dampened articles.

Modern plants are generally well ventilated, the bulk of the work is done in closed apparatus, and noxious solutions are drawn off by drain pipes at the bottom of the machines. Nevertheless, the average cleaning establishment is exceedingly malodorous, and gastro-intestinal disturbances and skin diseases are frequent among the workers, particularly among the spotters.

Workers who are likely to get their hands soiled with volatile solvents should wear impervious sleeves, gloves and aprons. If they are exposed to the mists of these solvents, they should apply a protective ointment of the lanolin type to the face and neck.

ELECTRICAL APPARATUS MANUFACTURE

(See also Batteries and Machinery Manufacture)

The basic requirements in the construction of electrical apparatus are good conductors and insulators, and raw materials used must be carefully selected and treated.

Conductors are made chiefly of copper and carbon, and it is necessary that the copper be as free as possible from arsenic, lead, antimony, and other impurities present in the ore.

Refining is done by electrolysis and may be applied to the raw copper or to the "anodes" secured by smelting. In smelting, copper sulphides and other ores are concentrated, often by flotation with sulphuric acid and oil, and then roasted. The oxide remains and

is reduced with carbon and a silicious flux to a *matte* containing 40 to 50 per cent of copper This is then placed in a reverberatory furnace "poled" with wood to remove occluded gases The resulting product is usually cast into blocks called "anodes" which are over 99 per cent pure They are further refined by electrolysis which deposits the copper as "cathodes" These ingots contain only minute traces of arsenic, antimony gold and silver They are then recast into the desired shapes, drawn into wire formed into bars and strips when conductors for heavy currents are required as for electric furnaces, or are turned to make terminals and other parts.

During the process of smelting the workmen are exposed to fumes of carbon monoxide sulphur antimony arsenic and other substances.

Various disorders occur among unloaders of copper ore smelters, electroplaters, turners, filers scourers, and polishers which are attributed to the arsenic and other impurities in the dusts and fumes which arise in the different operations. The lesions are dermatitis, gingivitis, stomatitis greenish discoloration of the teeth and perforation of the nasal septum Tattooing is sometimes seen from penetration of the skin by minute particles of copper Similar conditions result from working brass and bronze. Pricks from handling copper wire show a marked tendency to become infected When copper is subjected to heat, the fumes often cause severe constitutional symptoms known as "copper fever" (See chapter on Copper for description of its pathological effects.)

During electrolysis besides exposure to acid vapors the workmen often receive burns and shocks from electric current of low voltage and high amperage

Carbon is used in numerous forms as anthracite in the manufacture of brushes for dynamos and motors as anthracite coke for electrodes and carbon plates for batteries as retort coke and petroleum coke for many purposes as soot compressed to make pencils for arc lamps as pitch and tar used alone or in pastes for making dynamo brushes, electrodes, and microphone carbons

Articles molded of carbon are usually composed of a mixture of carbon and tar but for such purposes as making pencils for arc lamps in which it is desired to increase the luminosity or conductivity mineral substances are added These consist of cerium oxide calcium or strontium fluoride soluble silicates alkaline phosphates or borates, potassium chlorate saltpeter etc In the manufacture of dynamo brushes copper is incorporated in the mass of carbon as powder wire, or thin sheets Iron and bronze are sometimes used in telegraph wires. Less often other conductors are employed in electrical apparatus, *e. g* aluminum aluminum bronze, silver and alloys used for calibrated resistances which contain nickel chromium, manganese nickel-chromium and manganin

Electrodes are commonly made of carbon especially for electrothermal apparatus such as electr- aces The carbons are mixed

with tar or pitch and heated to convert them into graphite. The paste is prepared in an apparatus similar to the mechanical kneading trough of bakers. Electric arc furnaces in which the materials to be heated themselves act as the electrodes are often used

Graphite is prepared by passing a strong electric current through a mixture of coke, gasoline, pitch, and silica or iron oxide. After being heated the electrodes are scraped or sharpened on grindstones, or drilled to take metal fittings. For special purposes they are covered with a layer of aluminum oxide, carborundum, or magnesia.

The negative electrodes of Leclanché cells are made of amalgamated zinc which is first cleansed with sulphuric acid The electrodes are then plunged into mercury or a solution of mercury in nitric or hydrochloric acid.

Switches and measuring instruments are often made of brass, and cups of mercury are sometimes used for obtaining contact. (For dermatitis caused by brass, bronze, and mercury see these subjects.)

Insulators are made of many different materials. Ebonite, marble bakelite, slate, glass, porcelain, asphalt, paraffin wax, and wood afford supports for the apparatus, or such substitutes as steatite (derived from talc) asbestos sheets, and natural or compressed mica are employed.

For insulating wire, more pliable materials are used, such as gutta-percha, India rubber impregnated jute, impregnated paper oils, resins, and synthetic waxes such as chloronaphthalene. (See Synthetic Waxes.)

Gutta-percha can be used alone after it has been softened by heating or mixed with resin and tar and known as "Chatterton's compound. The wire is passed through a tank containing the insulating material or it is coated by a piston machine. After receiving the proper coating, it is bound with wrappings of cotton thread or webbing These operations are performed by machinery

India rubber being less costly than gutta-percha is commonly employed for insulation A layer of rubber is applied to the conductor and afterwards vulcanised with 1 to 3 per cent of sulphur in an autoclave at 120° C To prevent the sulphur from attacking the copper it is necessary to plate the conductor before it is insulated Oxidized oils or inert matter such as chalk, talc, or lamp black are often added to the rubber

Jute is impregnated with linseed oil paraffin, or bituminous material to increase its electrical resistance before being applied as an insulator

Manilla paper is cut into strips, wound around the conductor then heated and impregnated while hot with a mixture of mineral oil and resin.

Liquid insulators are used for transformers and other special types of insulation They consist of heavy oils of petroleum and resin obtained from the distillation of colophony The coils of the transformers are coated by immersion in baths filled with the oil

Copper parts and the coils of small generators or motors receive

many coats of varnish with a base of India rubber celluloid shellac, gum-lacquer or resin

Solvents employed include various alcohols amyl acetate acetone and benzene

Enameled wire is used for small work and for winding motors and generators. The enamel consists of a mixture of vegetable oils and gum A solvent is added the mixture is kept at a temperature of 30° to 40° C in a tank and through this the copper wire is passed After receiving the coat of enamel the wire is fired at 200° C in a small vertical furnace with an exhaust at the top to remove the fumes and gases. It is necessary to repeat the process several times before the proper coating is obtained

Electric cables are frequently insulated with jute impregnated with hydrocarbons mixed with fatty materials. The cable is then enclosed in a sheath of lead and this in turn may be covered with cordage asphalt steel ribbons, or water resisting material according to the purpose for which the cable is intended

Electricians may get "chloracne from handling wire or condensers insulated with chloronaphthalenes and chlorodiphenyls. (See Synthetic Waxes) They may get dermatitis from phenol-formaldehyde resins, vinyl carbazole and other resins used for insulation Makers of electronic tubes may get x-ray burns from the leakage of rays which may amount to 2 to 5 radons per day

Iron plates for electrical machines are cut punched and shaped by machine tools, and in some cases are annealed after cutting (See Machinery Manufacture) Insulating varnishes with a base of pitch and mineral oils synthetic resins waxes or organic products derived from formol and phenol may be used Of these bakelite in the 1 state (colophane) dissolved in alcohol is the most widely employed

Workmen in this industry are subjected to skin diseases chiefly from exposure to dust especially that of copper brass, and lead produced in shaping and polishing the parts from nitric acid and its fumes in scraping or cleaning mercury fumes from solvents in the manufacture of electrodes to the effects of humidity and heat and to burns from electric current. (See Chapter on Physical and Mechanical Agents) Dermatitis has been reported due to contact with sulphuric acid and oil on copper wire. Mercury poisoning has occurred among workmen who make electric meters clean electrodes and radio apparatus and fill small cylinders with mercury

Burns and fatalities from electric shock occur among fitters of electrical apparatus and workmen engaged in electrolyzing and manufacturing processes but more frequently in occupations apart from manufacture such as traction and distribution Although aerial linemen incur the greatest number of fatal shocks workmen in generator and transformer stations are sometimes injured or killed by the current Dermatitis from rubber gloves has also been reported among linemen

In the preparation of bakelite the skin and mucous membrane

are subject to a form of dermatitis called "bakelite itch." (See Bakelite.)

Symptoms of headache, vertigo, vomiting and constipation are observed among workers who saw and polish ebonite, apparently due to the high percentage of lead in the dust or to the fumes containing sulphuretted hydrogen, seleniuretted hydrogen, and mercaptan.

The various solvents, acids, tar, pitch, soot, etc., may give rise to burns, eruptions, and neoplastic lesions of the skin.

For specific effects of the various irritants encountered in this industry reference should be made to the following subjects:

	Page		Page
Acetone	331, 914	Lacquer	447, 461
Alcohol	918	Lamp black	218
Anthracene	227	Lead	208
Antimony	176, 919	Mercury	18-, 927
Arsenic	178, 919	Nitric acid	916
Asbestos	226	Oil	232, 928
Asphalt	226	Paraffin	240, 244
Bakelite	771	Pitch	226
Benzene	920	Resin	332, 463
Benzine	920	Rubber	45, 405
Brass	203	Sulphuric acid	917
Bronze	203	Tar	663
Copper	170, 923	Varnish	446
Heat	200	Waxes	333, 936
Hydrochloric acid	915	Zinc	199, 936

As in other industries both cutaneous and systemic hazards are being greatly reduced if not eliminated by modern technique which increasingly employs mechanical and automatic methods of operation. It is nevertheless still necessary to observe careful prophylaxis and to supervise closely the operation of exhaust apparatus in order to guard against lead and mercury poisoning, the chief dangers to workmen in the construction of electrical apparatus.

ELECTRICAL INSULATORS

Some of the chemicals used for electrical insulation are causes of occupational dermatitis. The following is a list of those having been reported as causes of dermatitis:

Chemical	*Type of Lesion*	*Used in Occupations*
Rubber	Eczematoid dermatitis	Wire insulation, wire stripping
Coal tar pitch	Acne, photosensitivity, Melanoses, keratoses	Wire insulation, wire stripping Wire insulation, condenser mfr.
Asphalt	Acne, photosensitivity, melanoses	Wire insulation, condenser mfr.
Vinyl resins	Eczematoid dermatitis	Wire insulation, condenser mfr.
Solid chloronaphthalenes	Acne	Wire insulation, condenser mfr. Wire strippers
Solid chlorodiphenyls	Acne	Wire insulation, condenser mfr. Wire strippers

Chemical	*Type of Lesion*	*Used Occupations*
Chlordiphenyl	Acne	Wire insulation, condensor mf Wire strippers
Vinyl carbazole	Eczematoid dermatitis	Condensor mf
Phenol-formaldehyde resin varnish	Eczematoid dermatitis	Condensor mf
Asbestos	Warts	Wire insulation
Dyed paper	Eczematoid dermatitis	Cable splicers

ELECTROTYPE WORKERS

In setting up electrotyping plates and molds workers come in contact with graphite and synthetic waxes. Dermatitis from graphite is rare but the synthetic waxes may cause acne (See Synthetic Waxes.) The electrolytes in which the molds are plated may cause dermatitis (See Electroplating.)

The solvent used in cleaning the plates are probably the most frequent causes of dermatitis among electrotype workers. Plates are usually cleaned by dipping cloth into a can of petroleum solvent and manually wiping the inks off the plate This practice may cause solvent dermatitis (See Solvents.) Plate and press cleaning should be done with long handled mops or brushes so as to prevent soiling of the skin with the cleaning solutions.

ENAMELERS

Enamelers may get dermatitis from alkalis acids and solvents which they use to clean metal surfaces before enameling them The thinners in the enamel may also cause dermatitis. Rarely do the pigments cause trouble although chromates may cause allergic dermatitis. Workers using strong acids, solvents and alkalis to clean metal surfaces should wear rubber gauntlets. Those applying the enamel should wear washable leather or fabric gloves and they should be cleaned daily

ETCHERS

Nitric acid is usually used to etch metal plates. (See Electroplating.) Hydrofluoric acid is used to etch glass. The surface of metal is protected from the nitric acid by a resin such as Dragon's blood The surface of glass is protected by paraffin wax. (See Glass Manufacture.) Etchers should wear rubber gauntlets and impervious aprons.

DERMATITIS FROM EXPLOSIVES

In times of peace explosives are not a large factor in the general causes of industrial dermatitis. In wartime, however dermatitis from explosives is a serious problem to those concerned with the prevention of industrial diseases.

Explosives may be classified in the following manner (1) propellants, used to propel projectiles, and (2) military high explosives, used for bursting charges and for setting off the more stable high explosives

The propellants are smokeless powder and black powder

The military high explosives are subdivided, the more stable explosives being used for bursting charges and the sensitive explosives for primers, fuses, boosters and detonators. Sensitive explosives are tetryl mercury fulminate lead azide, lead styphnate, sensol and nitroglycerin. Stable explosives are trinitrotoluene (TNT) amatol ammonium picrate (explosive D) lyddite (chiefly picric acid) pentaerythritoltetranitrate (PETN) hexite (hexanitrodiphenylamine) and dinitrotoluene (DNT)

Tetryl.—Tetryl, or trinitrophenylmethylnitramine, is a light yellow crystalline powder It is made by sulphonating dimethylaniline and then adding this to nitric acid. The tetryl is separated from the acid mixture and purified by recrystallising from a solution of *benzene or acetone*. It is then taken to the drying chamber and dried

Dermatitis caused by tetryl is probably the most frequent cutaneous hazard accompanying the manufacture of munitions. It occurs in the making of tetryl especially in the drying house, where it develops in about 60 per cent of the workers it occurs also in the production of pellets and in the loading of fuses and boosters. One shell-loading plant, for example, with a working population of 6,304 exposed to tetryl has reported 1 904 (30 per cent) having tetryl dermatitis in the first six months of operation

Dermatitis generally occurs during the first three weeks of employment among those who have never before been exposed to the material cases reaching a maximum number about the third week. Most workers become "hardened from one to four weeks after the development of dermatitis and are no longer irritated by tetryl. Especially is this true if they continue working while being treated It was noted at one shell-loading plant that about 85 per cent of the workers who had been affected became *non-reactive* while at another although exact figures are not available, the incidence of dermatitis became lower the longer the workers were employed A small percentage of workers apparently never become completely insensitive and dermatitis develops whenever they are exposed even to minute quantities of tetryl. The *amount remaining* on a fellow worker s street clothes has in some instances been sufficient to light up dermatitis in a susceptible worker although the contact lasted only during the ride home. Some workers become "hardened more gradually or to a lesser degree and never quite to the point of complete immunity

The workers most frequently affected are those taking the tetryl into and out of the drying house, where they are exposed to large amounts of tetryl dust those packing the tetryl for shipment, those blending tetryl with graphite in the loading plants those working

at the pellet making machines those inserting the pellets into boosters and those loading powdered tetryl into booster bags. The blending of tetryl is done in explosion-proof compartments, the operator being outside at a considerable distance (remote control) The pelleting is done in a similar manner except that the operator watches through a slit in the walls or sees the operation from a distance by means of mirrors.

The most frequent sites of tetryl dermatitis are about the mouth on the cheeks, around the eyes and on the neck In some cases there is considerable edema of the face the eyes being swollen shut. Dermatitis of the hands, the arms, the genitals and other parts of the body touched with soiled hands may also occur but is infrequent Nosebleed without ulceration of the nasal mucosa often occurs The skin itches, then becomes erythematous and papules and vesicles may develop. The latter may break and ooze Later roughness and scaling may occur The palms and fingers are usually stained dark yellow and the hair of blonds becomes a typical tetryl red Most workers show staining of the hands, and a few coloration of the hair without any evidence of cutaneous irritation Workers thus affected are sometimes called "canaries." The epithelium of the palms is indelibly stained and it takes two or three weeks after exposure ceases for the stain to fade out.

The treatment of tetryl dermatitis consists in the application of cold boric acid dressings to the swollen face followed by mild *ointments as the swelling disappears and desquamation occurs.*

The stain on the hands is difficult to remove The use of a 10 per cent aqueous solution of sodium sulphite followed by washing with soap and water is thought to be the best way to remove it The sodium sulphite may be incorporated into the soap or potassium sulphite may be put into liquid soap which reduces the time required for removal of the stain. This method of washing the hands also serves as an indication of the removal of the free tetryl for as long as there is free tetryl on the skin a purple color will show in the sodium sulphite solution

The following preventive measures are recommended (1) Freshly laundered coveralls should be provided daily for every worker exposed to tetryl (2) Workers handling tetryl should wear (*a*) soft washable leather gloves fastened at the wrists so that the dust cannot fall into the gloves (*b*) impervious sleeves fastened around the glove at the wrist and extending up to the axilla to protect the arms and (*c*) impervious aprons for the protection of the anterior surfaces of the body (3) As compulsory shower baths after work are an important factor in the prevention of tetryl dermatitis, time at the company's expense should be allowed the workers for taking the baths. (4) Since the skin of the face is affected from touching it with soiled fingers and from irritation caused by the respirator touching the face a protective preparation should be applied to it. Such an application should be of the invisible glove type reinforced by a powder to prevent it from being easily penetrated by sharp particles.

The formula given in Table 14 was found to give better protection than any other available. The shellac forms the film on the skin when the alcohol evaporates. In the film are embedded the solid ingredients for reinforcement. The perborate liberates oxygen when it is wetted. The oxygen tends to detoxifi tetryl. The linseed oil plasticizes the shellac and the carbitol permits the film to be removed after work by washing with water.

TABLE 14.—PROTECTIVE PREPARATION AGAINST TETRYL DERMATITIS

	Parts
Shellac	13
Isopropyl alcohol	31
Linseed oil	4
Titanium oxide	12
Sodium perborate	13
Talcum	20
Carbitol (monoethyl ether of diethylene glycol)	3

The water-soluble type of invisible glove application also gives considerable protection. The formula given in Table 13 incorporates it with a reinforcing powder.

TABLE 15.—WATER-SOLUBLE APPLICATION

	Parts
Casein	20
Zinc oxide	20
Iron oxide	2
Water	56

Reliance for the prevention of tetryl dermatitis should not be placed on protective ointments alone. These should be used in conjunction with all the other preventive methods mentioned. All workers need not use all these protective measures. Those who have worked for a long time without getting dermatitis or those who have become non-reactive need not do any more than wear clean protective clothing and take shower baths after work. Only new workers and those who are sensitive to tetryl must observe all these preventive measures.

Systemic poisoning from tetryl is a disputed subject. While some cases have been reported most authorities deny its occurrence.

Petrolatum inserted into the nostrils several times a day may prevent congestion of the nasal mucosa and nosebleed. The hair can be protected from the dyeing action of tetryl by wearing a close-fitting cap or hood.

Trinitrotoluene (TNT).—Trinitrotoluene or TNT is the most commonly used bursting charge. It is made by nitrating toluene to mononitrotoluene nitrating this to dinitrotoluene and then nitrating this to trinitrotoluene. This is washed with hot water until there is no more acidity. Then the neutral trinitrotoluene now in the form of an oily liquid is run into crystallizing kettles and from there into graining kettles. It is then transported to where it is boxed with non-sparking tools. Workers with this explosive should wear shoes containing no nails.

Trinitrotoluene resembles light brown sugar. It is soluble in ether, acetone and alcohol but is insoluble in water. On entering a room in which the dust of this explosive is present one experiences a bitter taste.

Dermatitis from trinitrotoluene begins to occur at the operation in which the product is washed with hot water to neutralize the acid and occurs from there on at every stage of the manufacturing, packing and bomb and shell loading processes. Workers engaged in unloading the boxes at the plants where shells are loaded, those pouring the trinitrotoluene into the melting boxes, those pouring it into shells and bombs, those drilling holes in it in the shells to make room for the booster and those inserting it into primers are especially likely to become sensitized and show dermatitis after five or more days of exposure. The hands, wrists and forearms are most commonly affected, but the dermatitis is often found at points of friction such as the collar line, the belt line and the ankles. A more or less generalized dermatitis may occur but is rare. The lesions on the palms are characteristic, resembling somewhat the deep-seated vesicles of a phytid. They are deeper seated and larger (pea-sized) and are accompanied by considerable edema. The dorsa of the hands are also usually edematous, and even the forearms up to the elbows may be affected. In seven to fourteen days the inflammation usually subsides and the skin peels in large thick pieces from the palms, in smaller pieces from other parts, leaving new skin beneath. The lesions on other parts are not characteristic, consisting of papules and vesicles followed by flaky desquamation.

Trinitrotoluene stains the skin of the hands a light yellow and discolors the hair to a reddish blond.

It may be taken into the system through the respiratory and gastro-intestinal tracts and may be absorbed through the skin to cause anemia, leukopenia and yellow atrophy of the liver. Workers exposed to it often show cyanosis, or "blue lip," a livid purple of the lips and blueness of the face. They should be examined periodically for changes in the blood and hepatic damage.

The treatment of dermatitis caused by trinitrotoluene consists in the application of mild wet dressings such as boric acid solution and solution of aluminum acetate in the acute stages and the use of mild ointment such as boric acid ointment or zinc oxide ointment when the acute symptoms subside.

Workers with mild dermatitis should be treated while working in order to give them an opportunity to get well on the job and become "hardened," as the majority do. While working they should be given protective clothing in the form of dustproof sleeves and aprons, in addition to a daily change of clean coveralls, stockings and underclothes. Washable soft leather gloves with smooth seams should also be provided and cleaned daily. They should fit snugly at the wrists to prevent the entrance of the dust of trinitrotoluene, and the sleeves should be fastened over them at the wrists. All workers with this explosive should take cleansing showers after work before leaving

the factory and they should wash their hands before their meals. A liquid soap containing 10 per cent potassium sulphite may be used.[1] This will give a purple color as long as free trinitrotoluene is on the skin. The Webster test will also show the presence of this substance on the clothes or the skin. It consists in dissolving 10 per cent sodium hydroxide in alcohol and applying a drop to the clothing. A purple color develops if trinitrotoluene is present.

All workers should be given the protective clothing advised in the foregoing paragraph. While ointments are not to be relied on to give as much protection as the measures recommended, if for some reason or other they must be used the type described for protection against tetryl is also the best for protection against trinitrotoluene.

Amatol and Ammonal.—Amatol is a mixture of ammonium nitrate and trinitrotoluene. It is made by preheating ammonium nitrate and letting it mix with molten trinitrotoluene usually in the proportion of 50 parts each or that of 80 parts ammonium nitrate to 20 parts of trinitrotoluene. The hazard treatment and prevention of dermatitis are the same as for trinitrotoluene. Ammonal is a mixture of ammonium nitrate and powdered aluminum. Dermatitis from it is not as frequent as that from amatol.

Ammonium Picrate (Explosive D).—Ammonium picrate or explosive D is made by reacting a hot aqueous solution of picric acid with ammonia and crystallizing the ammonium picrate by cooling. In the form of the wet crystals it is taken to the dry house and dried by circulating warm air. It is then packed in waterproof boxes.

Ammonium picrate consists of orange colored needle shaped crystals. It is soluble in water has a bitter taste and dyes the skin, hair and clothes of workers exposed to it. It is used as a bursting charge in armor piercing shells, into which it is loaded by pressing. Because it attacks metals, the inside of the shell is coated with a non-metallic paint or varnish.

From the time it is in the wet crystal stage up to the time of loading the shells ammonium picrate causes sensitization dermatitis among workers exposed to it. Those handling the dry product are the ones most affected. The face is usually involved especially around the mouth and the sides of the nose. There are edema, papules, vesicles and finally desquamation. "Hardening" occurs as described for tetryl and trinitrotoluene. The treatment and the preventive measures are the same as for tetryl and trinitrotoluene.

Picric Acid.—Picric acid or trinitrophenol can be made from benzene or from dinitrophenol. It is a lemon yellow crystalline solid only slightly soluble in water but soluble in alcohol benzene and other organic solvents. It stains the skin the hair and the clothing of workers yellow. It has a bitter taste.

Picric acid causes dermatitis similar to that described under ammonium picrate.

[1] Norwood, W. D. Trinitrotoluene (TNT): Its Effects. Removal from the Skin by a Special Liquid Soap, Industr. Med., 12, 206–208, April, 1943.

Mercury Fulminate.—Mercury fulminate is a brownish-yellow heavy crystalline solid made by the action of alcohol on mercuric nitrate. There is but little dermatitis among workers engaged in its manufacture. It is used in detonators and primers and is one of the most frequent causes of dermatitis in shell loading plants. It causes sensitization dermatitis and it can also cause ulcers if it enters abrasions. Because of its sensitivity mercury fulminate is stored wet. Before use it is dried and delivered in small amounts to the detonator lines. It may be used to fill the detonators while it is still wet and in this case the detonators are placed in drying rooms to dry.

When used for primers mercury fulminate is mixed with other ingredients, such as antimony sulphide or potassium chlorate. In the making of detonators there is a certain amount of exposure to the dust in practically all of the operations and most of the dermatitis from mercury fulminate occurs in a manufacture of detonators. In the making of primers the mercury fulminate is usually handled wet and the workers wear rubber gloves or finger cots.

Dermatitis from mercury fulminate occurs mostly on the face and anterior surfaces of the arms but other parts of the body may also be affected. If the wet primer mixture is dropped on the clothing the powder when it dries will sift through the clothing to the skin and cause dermatitis on the covered parts of the body. The inhalation of the dust of mercury fulminate causes nasal irritation. Rubbing the nose with soiled hands or gloves is often the means of carrying the chemical to the face. Conjunctivitis also occurs in a considerable number of these workers.

In occupational dermatitis the etiologic rôle of the other ingredients in primers and detonators must not be overlooked and if it is desired to find the actual cause of dermatitis among workers, patch tests should be performed with the various ingredients in the explosive mixtures. Petrolatum inserted into the nostrils will afford protection from nasal irritation as described under tetryl.

Hexite.—Hexite or hexanitrodiphenylamine is a yellow crystalline solid soluble in alcohol and in acetone. It is manufactured from dinitrochlorobenzene and it causes vesicular dermatitis of the hands followed by desquamation similar to that described under trinitrotoluene among workers engaged in its manufacture and among those engaged in loading it into shells and bombs.

Hexite is now being made and used but not in as large quantities as trinitrotoluene. The incidence of dermatitis from it is higher than that from trinitrotoluene. It causes irritation of the mucous membranes of the nose and the mouth and it stains the skin and the hair yellow. It also causes systemic poisoning similar to that caused by nitroglycerin.

Pentaerythritoltetranitrate (PETN).—Pentaerythritoltetranitrate or PETN a new explosive is used as a bursting charge. Dermatitis or systemic poisoning has not yet been reported as being caused by it.

Black Powder and Smokeless Powder.—Black powder was the first propellant, and until 1870 it was practically the only propellant used. Today, however, it is used only for igniter charges, for expelling charges from shrapnel, for primers and in the manufacture of fuses. Black powder is a mixture of potassium or sodium nitrate, charcoal and sulphur. It is only a rare cause of dermatitis.

Smokeless powder has entirely displaced black powder as a military propellant. It is manufactured by nitrating cotton with a mixture of nitric and sulphuric acid, purifying the pyrocotton, mixing it with ether and alcohol and pressing it into a colloid called "cheese," pressing the colloid through openings into macaroni-shape, cutting it into suitable sizes, drying and blending. Diphenylamine and graphite are added as stabilizers. There are some double base powders which contain nitroglycerin.

Dermatitis from smokeless powder is rare. Workers operating dehydrating presses are exposed to fumes of ether and alcohol, and dilatation of the blood-vessels of the face has been observed in those whose exposure has extended over a number of years. Workers with double base powder sometimes complain of headaches as the result of the systemic effects of nitroglycerin. The wearing of rubber or washable leather gloves will reduce the cutaneous absorption of nitroglycerin and help to prevent systemic effects.

Lead Styphnate, Sensol and Lead Azide.—Lead styphnate is a reddish-brown powder used in priming mixtures. It is manufactured by reacting resorcin with sulphuric acid and then nitrating to form trinitroresorcinol. This is then mixed with magnesium oxide and reacted with a solution of lead nitrate. Lead styphnate turns the hair and skin yellow and causes dermatitis similar to that described under tetryl.

Sensol, a yellow powder, manufactured by the action of sodium nitrate on ammoguanadine sulphate, is also used in primer mixtures and causes dermatitis similar to that of tetryl.

Lead azide is manufactured by the action of lead nitrate on sodium azide. It is a highly sensitive explosive and is used in detonators and primers. It rarely causes dermatitis.

Nitroglycerin.—Nitroglycerin is made by adding glycerine to a mixture of sulphuric and nitric acids. To make dynamite, wood cellulose nitrates and infusorial kieselguhr are added to the liquid nitroglycerin. To make gelatin dynamite, nitrocotton is added to nitroglycerin. Nitroglycerin is sometimes added to smokeless powder (cordite) to give desired ballistic properties. It is also used as a propellant aid in firing trench mortars. Headache develops in workers with nitroglycerin when they are starting the week's work. In order to prevent this some of them carry a little of it in their hat bands. Nitroglycerin causes no dermatitis but can be absorbed through the skin and cause cardiovascular disease.

Comment.—Dermatitis occurs fairly frequently among workers filling primer cups. These may contain mercury fulminate, lead sulphocyanide, antimony sulphide, potassium chlorate and trinitro-

toluene. In most of these cases the trinitrotoluene has been found by patch tests to be the principal cause of the dermatitis. The palms are affected in a manner similar to that described under trinitrotoluene

Dermatitis from the tracer mix, consisting principally of strontium compounds and resinate occurs but rarely and the senior author has seen no cases of dermatitis from the igniter mix which contains magnesium and barium peroxide

Dermatitis occurs in workers engaged in the manufacture of fuses These may contain tetryl lead azide and mercury fulminate.

Boosters always consist of tetryl in the form of pellets or of powder

FARMERS

Farmers are subject to many occupational skin diseases. Poisonous plants with which they may come in contact insecticides and fungicides which they must use on plants and vegetables, fertilizers, such as calcium cyanamid and nitrates may cause dermatitis. In picking and packing fruits and vegetables they may become sensitized to the juices. (See Plants and Woods and Canning and Food.)

Infections such as impetigo or foot-and mouth disease, anthrax vaccinia, etc (see Biologic Agents) may be contracted from cattle The stings of bees hornets snakes etc are occupational hazards among farmers.

FEATHER INDUSTRY

Feathers and down for commercial purposes are derived from many varieties of birds and poultry Chickens ducks, and geese furnish most of the material for cushions mattresses pillows etc. while rare plumage obtained mainly from the heron swan ostrich pheasant marabou bird of paradise humming bird and egret is used for millinery and dress trimmings light wraps and other personal adornments Small feathers are often glued to a cloth and wire frame to make fancy designs or to simulate wings, etc.

Treatment of the raw material is the same regardless of the purpose for which it is intended The feathers are cleaned cured defatted and in many cases subjected to sterilization. They are first beaten to remove the dust then washed in soapy water or treated with boiling water and starch or some kind of whitening that impregnates the feathers and increases their weight. They are bleached with sulphur dioxide or hydrogen peroxide and dyed with aniline vegetable or mineral colors.

Dermatitis may be incurred from aniline dyes arsenic used in curing, bleaching and defatting agents glue solvents, sulphur dioxide hydrogen peroxide, soap benzine, benzene turpentine methyl alcohol and petroleum

Previous to disinfection the raw materials have been known to cause itching eruptions due to infestation with mites, fleas, bird lice, and other parasites peculiar to birds and fowl. (See chapter on Animal Parasites.)

Organic dust liberated during the process of beating the feathers has a suffocating effect on the workmen and may also produce septic infections of the skin such as boils and carbuncles.

The manipulation of feathers during renovation of mattresses pillows, and bed coverings which have been used by diseased persons may give rise to erysipelas, scarlet fever typhoid fever diphtheria, and measles. Unsterilized feathers imported from countries where smallpox is prevalent may infect the workmen who handle them

Disinfection may be carried out by use of superheated steam alone although in some factories other substances are added

A sterilization process was described by du Bray of San Francisco who in 1930 treated a case of chronic zinc poisoning (without cutaneous manifestations) in a pillow factory worker engaged in the renovation of feathers. His patient prepared a solution of zinc chloride three times a week over a period of four years by holding the crystalline powder in his bare hands and dissolving it in water in the proportion of 3 pounds to 1 gallon. After the feathers had been washed and dried in a centrifuge they were placed on a table near the renovator and drawn in by suction. After this, steam containing zinc chloride was also sucked in. Some fumes escaped from the renovator but the room was well ventilated and the author believed that the handling of the dry powder together with splashings of the solution produced chronic intoxication by absorption of zinc through the skin. It is probable that the poisoning occurred through inhalation of the zinc carried by the steam

Contact with this substance is capable also of causing an ulcerative dermatitis. (See Zinc.) Injury can be avoided by washing the part immediately with a dilute solution of hydrochloric acid ordinary soap and water will not suffice.

To prevent injury from dust, the operation of beating feathers should be carried out in totally enclosed apparatus or under a hood in which the exhaust removes the dust to a hearth or dampened chamber All material that may have been exposed to infection should be sterilized Prompt attention should be given to workers in case of cuts or abrasions, and gloves, masks, and convenient cleansing facilities should be provided.

FELT HAT MANUFACTURE

Although felt hats can be made from the fur of the rabbit hare muskrat, nutria or beaver most felt hats except the very expensive ones are now made of rabbit fur Wool is also used in cheap hats especially women's hats where stiffness and wearing qualities are not required but the process of felting wool differs materially from that of felting fur

Rabbits and hare skins are imported from Australia Russia France England and Poland The rabbits are caught chiefly by trapping They are killed and skinned and the pelts sun-dried and

shipped in bales containing from 2,000 to 4,000 pelts. Tularemia is a hazard in this part of the industry.

The bales of fur are opened in the fur-cutting factory and the skins, fur side turned in, are first put into a totally enclosed revolving drum containing wet sawdust and revolved until they become moist and pliable. They are then taken out of this drum and placed in another drum made of wire mesh in which they are again revolved, the sawdust sifting out through the mesh. They are then taken out and placed one by one on the opening board which consists of two pieces of wood standing upright on a table, the upper ends leaning towards each other to form an inverted V. The skins are drawn over the two posts. The feet, tails, and heads are cut off with a sharp knife, and the skins are slit through the abdomen and spread out. Women are employed at this job. Although dermatitis is rare, callouses occur on the index fingers of the right hand from pressure of the cutting knife.

The opened skins are then cleaned by a process known as "carding." This consists of brushing the fur with a fine wire brush to remove blood, dirt, and other foreign matter. Rabbit skins are stretched in a machine to smooth out whatever lumps or thick parts there may be in the pelt. The pelt is then taken to the shearing machines and coarse hairs are sheared off. The hair which is cut off is removed by a suction apparatus attached to the machine. The skins are now ready for carroting.

Carroting consists in brushing a solution of mercuric nitrate on the fur side of the pelt. Two kinds of carroting solutions are used, the yellow carrot and the white carrot. The white carroting solution of mercuric nitrate is more concentrated than the yellow carrot. The carroting solution is made in a small totally enclosed room which contains a large tank connecting by means of glass tubes with tanks of mercury and nitric acid situated outside the room. The required amount of nitric acid is allowed to run into the tank and then the necessary mercury is allowed to run into the nitric acid. The proportions are usually from 20 to 26 parts of mercury to 100 parts of acid. Heat is applied to the tank by means of surrounding steam pipes and the reaction between the nitric acid and the mercury takes place, resulting in the evolution of nitrous fumes and the formation of mercuric nitrate. When the reaction is completed, as can be determined by taking off samples from tubes situated outside the room, the solution is siphoned off. The room is opened and allowed to air. There is a hazard in this operation of accidental burns from nitric acid and mercuric nitrate. The concentrated solution of mercuric nitrate thus obtained is not actually used for carroting. It is diluted with 5 or 6 volumes of water. If white fur is to be carroted, a certain amount of hydrogen peroxide is also added to the solution. The concentrated solution of mercuric nitrate is corrosive and splashes of it burn the skin. The dilute carroting solution can also burn the skin if allowed to remain on for some length of time.

Carroting results in oxidation and hydrolysis of the fur keratin and a union of the keratin with mercuric nitrate to form keratin nitrate. Carroted fur when wet with hot water has the property of adhering, intertwining, shrinking, and mixing to form felt. Carroting can also be done with alkaline sodium peroxide chloric acid and other chemicals, but is most satisfactorily done at present with mercuric nitrate.

The application of the carroting solution to the fur can be done by hand or by machine. The carroters in either case wear heavy rubber gloves and rubber sleeves reaching above the elbow to protect the arms from the action of the carroting solution. In the carroting room there is a strong smell of acid which is irritating to the mucous membranes of those unused to it. A crockery bowl containing a dilute solution of mercuric nitrate stands on the table. Into this the carroter dips a brush and brushes the fur When the solution is applied by machine, a revolving brush dips into a trough of the carroting solution situated underneath and the fur is applied by the carroter to the top of the revolving brush In both operations there is considerable spray of mercuric nitrate over the carroting table. As splashes of the carroting solution sometimes strike the face of the carroters, some of them wear goggles to protect the eyes. The carroting solution may enter defects in the gloves or sleeves and irritate the skin. The spray around the table may irritate the skin of the face and in some instances causes conjunctivitis and irritation of the nasal and buccal mucous membranes.

Acid fumes continually arise from the carroting solution as well as from the carroted fur There is also a constant but slow reaction taking place between mercuric nitrate and the fur in which mercury vapor is given off These constitute skin and systemic health hazards to the carroters.

Discoloration of the oral and nasal cavities among the carroters was observed by Neal and Jones. This discoloration was of two types, coppery and white. A dark line on the gums closely resembling the line of lead poisoning was also noted in a considerable number of the workers. A black mottling of the enamel of the teeth was observed in some of the carroters. The carroters fingers and thumb nails were discolored brown or black and a callous formation occurred over the metacarpophalangeal joint of the index finger where the straps securing the carroting brush to the hand passed over the knuckle.

The wet carroted skins are spread on drying racks, usually by women who wear heavy rubber gloves and sleeves. Men sometimes employed at this job are less likely to wear gloves and, lacking proper protection for their hands, dermatitis usually occurs among them.

The yellow or rapid carrot is obtained by passing the pelts through the driers at a temperature as high as 240° F., for a period of fifteen minutes to one hour The white carrot is obtained by passing the skins through the driers at a lower temperature and for a longer

time After the pelts come out of the driers they are no longer irritating unless they are again moistened by water or by perspiration

The dried pelts are piled one on top of the other in large bins. Mercury vapor is constantly given off from the fur in the bins and should be removed by forced ventilation As the furs are needed they are taken from the piles and are first brushed by mechanical revolving brushes to smooth out the fur and then they are sent to the cutting machines. Workers who brush and cut carroted fur wear respirators as a protection against the hazard of mercurial poisoning They do not wear rubber gloves or sleeves but since the fur is dry occupational dermatitis is rare among them

The fur-cutting machines remove the fur from the pelt The fur is then sorted to eliminate scraps and put into a series of machines called blowers which clean the fur and expel it in a continuous flow resembling a mass of absorbent cotton The blown fur is then packed into 5-pound paper bags.

Scraps of fur are utilized by one of two processes The fur can be removed from the pelt by the action of dilute sulphuric acid in a tank which dissolves away the pelt, leaving the fur or the small pieces of scrap fur can be pasted on pieces of thick brown paper which then can be carroted and treated the same as ordinary pelts. Dermatitis has been reported among scrap fur handlers from the fur dyes especially paraphenylenediamine

The felt hat manufacturer buys the carroted fur from the fur cutter in 5-pound bags. A batch of fur is made by mixing new fur called fleece with remnants of fur and felt left over from previous batches The mixed batch is fed into a series of machines, the first of which is called a devil in which the batch is uniformly mixed and dust is removed From the mixing machine the fur is passed to a blower machine in which mechanical beaters separate the fine fur from the coarse hair and other foreign matter The fur comes out of the blower in the form of an endless roll of soft fluffy material resembling absorbent cotton Mixing and beating are done in one room the air of which is charged with hair and fur Men working in this room should wear respirators to protect them from mercurial poisoning There should also be adequate suction exhaust to keep the air comparatively free of fur and dust which may leak out of the mixing and blowing machines.

From this room the fur is taken to another room in which a wetted amount of the fur is fed into a coning machine The fur is sucked to the top of the machine. A hollow metal perforated cone, about 32 inches high is placed base down on a revolving stand and the door of the machine is closed Suction is applied at the base of the cone and the fur from the top of the machine is blown over the cone forming a thin film of fur In the old or wet process, a stream of water plays on the revolving cone of fur to make it adhere to the cone. The water serves to dissolve some mercuric nitrate out of the fur and makes it less irritating to the skin of the felters. In the newer process, there is no spray of water instead the metal

cone is moistened before it is put on the revolving stand. In the old process as soon as all the fur is deposited on the cone, the cone is taken off the stand and the wet fur cone is removed In the new process when all of the fur has deposited on the cone, a piece of wet burlap is placed over the top of the cone and another piece of wet burlap is wrapped around the body of the cone, then a metal cover is placed over the burlap and the whole is immersed in a solution of wetting-out agent usually consisting of a preparation of sulphonated castor oil. The object of the wetting-out agent is to allow the water to penetrate the felt and to aid in removing the felt from the metal cone. The solution of wetting-out agent also tends to maintain the pH of the forming solution somewhere near the neutral point and this lessens the danger of dermatitis from acid mercuric nitrate.

The cone is taken from the forming solution, the covers removed and the thin wet cone-shaped material of fur taken off the metal cone. A worker then squeezes the excess solution out of the cone-shaped fur spreads it out flat, inserts both hands and forearms into it, and again gently spreads it out flat on a piece of woolen cloth Twelve cones are piled one on top of another on the woolen cloth and then rolled over gently and squeezed out in water This operation is repeated until the cone-shaped piece of fur reaches the desired firmness, and is called "hardening" In some factories it is done by machine. Dermatitis of the hands and forearms may occur in this operation but is rare because the fur is still soft and the reaction of the forming solution is neutral.

The next step in manufacture is called "starting" or "first-felting" process. It consists in opening the bundles of formed and first hardened fur and wetting each cone with boiling water applied gradually by drippings from a brush so as not to injure the frail cone of fur The hot water has the property of felting the fur The felting occurs because the hairs become intermeshed and the enlarged parts of the barb of the hair prevent the fiber from unmeshing There is also intertwining and sticking together of the fibers, gelatinous with a coating of keratin nitrate

After the felt begins to form the cone shrinks, becomes stronger and can then be dipped into the boiling water and squeezed out. After each dipping the fur shrinks and the felt becomes tougher The starter inserts his hands and forearms into the cone between the dippings and spreads it out to avoid creasing in any one spot He places it in a roller machine which by revolving the cone and spreading the hot water evenly allows the felting to be uniform At this stage the cone of felt is of such size so that, when the hands are inserted the edges of the base reach slightly above the bend of the elbows. As the felt hardens it causes friction against the skin especially at the elbow The hot water in the starting tank becomes acidified by the nitric acid liberated from the carroted fur In addition to this sulphuric acid is often added to the hot starting solution It is in this operation that most of the dermatitis of felt hat makers occurs. The friction of the felt combined with the acid in the start

ing solution causes an erythematous, papular vesicular eruption of the hands fingers, and forearms up to and above the elbows. About 25 per cent of all the workers who begin to work at "starting" develop dermatitis but after three or four months they become "hardened" or immune. Those who develop such severe dermatitis that they must stop work or change to another department to get well rarely become "hardened."

Patch tests performed with the starting solution on affected workers fail to give positive reactions in twenty-four hours, indicating that friction is necessary to cause dermatitis.

After the starting operation the felt is passed either through sizing machines or multi-roll machines in which it is wetted and repeatedly pressed and from which it emerges in a firmer state and shrunken in size. The finger tips of men who handle the felt cone during this process become thin and sore when they first start to work. As the worker continues at the operation however the skin becomes tougher and calloused. Callosities and black discoloration can be noted on the balls of the hands and on the ends of the fingers among workers long in this occupation.

The felt is now ready for the dye house where it is treated with acid aniline dyes. Sometimes new fur is dyed before it is felted. When this is done chrome mordanted dyes are used. Dermatitis rarely occurs in the dyeing room although there is a hazard to workers who are sensitive to aniline dyes or chrome.

After the dyeing the cone is given a final sizing is shrunk to the proper size and taken to the drying room where it is dried on wooden racks. It emerges from the drying room 11 by 10 inches in size having been reduced from its original size of 27 by 20 inches.

The dried felt is now put on a machine to stiffen the brim. This is done by impregnating the brim with a stiffening solution of gum shellac in sodium carbonate. The alkaline stiffening solution causes dermatitis of the hands and forearms of sensitive workers. The cone is then placed on a tip stretching machine which wets and stretches the cone into a block shape. The brim is then stretched the whole hat is blocked and given to the "pouncer" who rubs or pounces the felt with sandpaper to make it smooth.

Derby hats are stiffened throughout the body and brim by treatment with shellac dissolved in alcohol.

The hat is now ready for the finishing department in which it undergoes more pouncing blocking polishing and shaping. The brims are cut to size and curled and sweat bands and ribbons sewed on. Dermatitis is uncommon in the finishing department.

Prevention of Dermatitis.—Carroters of fur and workers handling carroted fur should wear adequate protection against the action of acid mercuric nitrate in the form of rubber gloves and rubber sleeves.[1] Carroters should wear goggles and rubber aprons. Work

[1] The use of mercury carrot has been forbidden in Connecticut. Alkali carrots are used. Dermatitis may result from them, but is not as frequent as from the mercuric nitrate carrot.

ers who handle the wet carroted pelts should wear rubber gloves and sleeves. Those engaged in forming, starting and sizing felt hats should wear thin rubber gloves, loose waterproof sleeves reaching from the shoulder to the wrist and rubber aprons. Workers who apply stiffening solution to the hats should also wear rubber gloves and waterproof sleeves. There should be periodic medical examinations in this industry to detect early symptoms of mercurial poisoning as well as cases of dermatitis.

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Furriers.—Furriers sometimes develop dermatitis from the arsenic powder used to preserve furs, especially those of dogs imported from China. The fur dyes, especially paraphenylediamine and aniline black cause allergic dermatitis among those who dye and those who handle the furs. The mordants and oxidizing agents such as the bichromates may also cause dermatitis among fur dyers. Fur fleshers get erosion of the nails from the acid in the fleshy side of the pelt. Fur dyers should wear rubber gauntlets and impervious aprons and take cleansing showers before going home from work.

FIREPROOFING

Asbestos.—Asbestos is an effective and extensively used substance for fireproofing. The name is a commercial term applied to several fibrous minerals including chrysolite, anthrophyllite, amosite, crocidolite (blue asbestos), fibrous tremolite and hornblende. The ores are found chiefly in Canada, Russia, Italy, Cyprus and the Transvaal.

Asbestos corns are wart-like callosities occurring on the palms or fingers, and occasionally on the soles or legs. They are caused by tiny slivers of asbestos entering the skin and causing hyperplasia. Microscopically the skin presents a picture of slow chronic irritation. The horny and Malpighian layers are increased. Round-cell infiltration is noted in the papillary layer. Asbestos fibers or crystals may be seen and they are the agents responsible for the rete mucosum basal layers, and the giant-cell formation. The workers call these little tumors asbestos corns or asbestos warts. They sometimes become tender from pressure of the tools and the worker will attempt to remove the spicule of mineral with a penknife or some other sharp instrument. The workers state that unless every bit of the fiber is removed the corn will not be cured.

The long fibers are spun into yarn and woven into cloth or felted into sheets and packings in much the same way as ordinary textiles. The short fibers are usually combined with some form of binder for mattresses pipe coverings, etc

Mineral wool rock wool slag wool and glass wool have fire-resisting properties

Mineral wool (or cotton) is made by subjecting molten slag to a jet of live steam This results in the formation of fine threads of slag The basic slag is obtained from steel convertors and is crushed and ground before being converted into wool

Slag contains 14 to 20 per cent of calcium phosphate and 10 to 20 per cent of free lime It may cause dermatitis when in prolonged contact with the perspiring skin.

Mineral wool is used as a heat and sound insulator and also as a fertilizer

Crushing grinding and bagging basic slag and mineral wool are dusty operations and the sharp particles may wound the skin and the alkalis of the slag may irritate it The prevention of dermatitis from basic slag consists in the wearing of clean closely woven work clothes daily application of protective ointments of the type which leave a dry impervious water resistant film on the face the wearing of leather gloves and the taking of cleansing showers after work.

The importance of the asbestos industry is constantly increasing as new uses are being found for the material At present many thousands of tons are processed each year for fireproofing buildings theater curtains and scenery blankets, mattresses, firemen's suits, gloves shoes, leggings helmets, etc for laboratory equipment gas mantles awnings, conveyor belts for carrying hot materials, woven sheet packings, listings tape, rope, cord wick, gaskets, brake-band linings, and clutch-facings of automobiles and for innumerable other purposes

Asbestos cloth treated with rubber is made into gaskets, and the short fiber combined with rubber or some other binder is used for fireproof mattresses For the so-called "85 per cent magnesia pipe covering about 15 per cent of fiber is mixed with 85 per cent of basic magnesium carbonate and water pressed dried and applied to the pipes in glued canvas jackets. For boiler insulation asbestos fiber mixed with plastic clay and water is applied with a trowel

For electrical fittings and household appliances, asbestos gilsonite, cement, and oil are ground together and compressed in molds which are baked in ovens polished and lacquered

Asbestos and cement are combined to make corrugated sheeting millboard lumber and floor tile Roofing shingles and lumber are manufactured by mixing about 75 per cent of Portland cement with asbestos fiber and coloring matter in a cylindrical mixer provided with paddles The mixture is spread on a conveyor belt, sprayed with hot water compressed in a rolling machine and cut to size by a rotary cutter The sections are then further com-

pressed by hydraulic machines, cured, trimmed and punched for nailing

Shingles and lumber may also be made by the laminated or 'Eternit' process, in which the cement, fiber and coloring material are mixed with a large quantity of water agitated in a beater and pumped to a paper machine which builds up sheets in laminations to the desired thickness.

Asbestos paper and millboard (which is simply a thicker paper) are made by mixing asbestos with a large amount of water to make a thin slurry and agitated in drums. Starch, flour or size, and sodium silicate are added and the whole is treated in a paper machine in the same way as other paper pulp. Sodium silicate coatings are added to make paper of two-ply or more.

Fireproof paper may also be made of aluminum sulphate and asbestos fiber moistened with zinc chloride. After being washed with water the mixture is treated with aluminum sulphate and rosin soap and made into paper in the usual way.

Some types of asbestos packing are made by mixing the fiber with fillers such as clay, barites, magnesia, iron oxide, graphite or cellulose and gums, lac, or rubber dissolved in benzene for binding. The mixture is molded into sheets, several of which may be glued together and reinforced with copper or lead foil.

Paint is fireproofed by mixing it with the short fibers of asbestos.

For the manufacture of asbestos products, the crude fiber is delivered at the factory where it is crushed in a chaser mill, fiberized and freed from rock impurities. For textile purposes, the long fibers are mixed with a small amount of cotton in revolving beaters to facilitate spinning and weaving, then carded by rollers equipped with sharp steel bristles which comb the fibers straight and remove the dust and rock particles still present. After this, the material is separated into rovings which are gathered on a jack-spool and spun into yarn. Weaving into fabric is done by the usual processes.

When the yarn is to be used for brake-bands or packings, it is usually reinforced with fine copper, brass, or lead wire, the product being known as metallic yarn. This is woven into strips that are processed with rubber and other ingredients. The asbestos cloth used for packings may be coated or impregnated with rubber compounds, oil, or flake graphite.

In the manipulation of asbestos, and especially in the operations of carding, spinning and weaving, so many cases of tuberculosis and fibrosis of the lungs have resulted from inhalation of the dust that the pathological entity known as *asbestosis* is now regarded as comparable to silicosis. Although statistics show a marked decline in the incidence of such diseases since the adoption of improved ventilating systems, in 1927 a fatal case of pulmonary fibrosis was reported in Great Britain due to this cause.

Asbestos workers on the island of Cyprus frequently suffer from chronic conjunctivitis which affects mostly those engaged in grinding, screening and packing the raw material in sacks.

Warty growths have been reported by Dewirtz which contain asbestos. Penetration of the skin by these particles appears to produce chronic inflammation that results in a thickening of the rete mucosum and the basal layers and the formation of giant cells.

There is danger of lead poisoning during the weaving of asbestos, in which a thread of lead is added to the weft. Cutaneous hazards are also encountered in handling wires of copper and brass which, like lead, are used to strengthen the yarn.

Other hazards in fireproofing with asbestos arise from the substances and solvents contained in the various compounds, such as glue, cement, zinc chloride, rosin, benzene.

In working with artificial asbestos or with glass wool which is made of very minute threads of glass, the clothing becomes filled with sharp dust particles that irritate the skin. The effect is particularly severe when the skin is wet with perspiration.

Other Fireproofing Methods.—Many manufacturers have private formulas for making their products incombustible or heat resistant, and we will merely attempt to give below a general idea of methods that have been found effective.

Soaking in ammonium sulphamate solution is one of the newest methods for flameproofing of fabrics.

For cotton, silk, or paper wire-covering the material is impregnated with a mixture of wax like chlorinated naphthalenes, about 70 to 90 parts, and chlorinated rubber or polyvinyl chloride, 5 to 30 parts. In manipulating this mixture there is danger of acne from contact with the chlorinated naphthalenes.

One large manufacturer of inflammable materials (synthetic resins, celluloid, etc.) fireproofs the clothing of employees as follows: Ordinary work-clothes are boiled in a strong solution of soap and borax for twelve hours and then rinsed and dried. Next they are soaked in a solution of tin stannate of 1.20 gravity, wrung out, and dried again. When dry they are soaked in cold ammonium sulphate for fifteen minutes, rinsed in cold running water for one hour, and dried. In this particular plant protective measures are so carefully observed that it is doubtful whether dermatitis is incurred by the workers from any of the irritants involved.

Tent canvas and other coarse cloth can be rendered fireproof by a mixture of linseed oil, litharge, sugar of lead, lampblack, oil of turpentine, umber, Japanese wax, soap powder, manila copal and caoutchouc varnish boiled together and applied to the cloth. The hazards in this method arise from lead, lampblack, turpentine, Japanese wax, resins, and the various solvents.

Other textiles may be fireproofed as follows: (1) By treating with ammoniacal salts, borax and boric acid. (2) Steeping for an hour in a 14° Bé solution of sodium stannate. Some manufacturers have followed this by drying the material, immersing it in ammonium sulphate, and drying it again. (3) A solution of sulphuric acid, bone ash, and water is allowed to stand for two days at moderate heat. It is then mixed with a solution of magnesium sulphate,

water and a large amount of ammonia. The precipitate is pressed and dried. Sodium tungstate and wheat starch are mixed with indigo-carmine and added. The whole is then boiled with enough water to make a slime in which the fabric is placed. The sulphuric acid and the various alkalis are risks in these operations. Glue silicates, phosphates, and titanium salts are also used in various methods.

Paper can be rendered fire-resistant by applying a strong solution of alum or mixtures of ammonium sulphate boric acid and borax.

Soft wood can be hardened preserved and fireproofed by impregnating it with metallic salts such as ammoniacal solution of copper and zinc salts mixed with borax, potassium chromate and cement powder either with or without salicylic acid and sodium fluoride. The alkalis, chromates and metallic salts constitute cutaneous hazards.

Wood paper or cloth may also be treated with a solution of antimony chloride in amyl acetate or other solvents. Both of these are capable of causing dermatitis. (See Antimony and chapter on Solvents.)

For roofs after the roofing paper is put on coal tar and lime (burnt, but not slaked) are boiled together using 15 parts of lime to 100 parts of tar and the mixture spread on. The hazards in this method are tar and lime.

Mica is a natural hydrous silicate which is mined and separated into sheets. When powdered it is used in paints, lubricants and textiles. It can be laminated to desired thickness and size by glues and varnishes and used as electrical insulation stove doors and tiles. Mica flakes may cause dermatitis by penetration of the skin.

THE FISH INDUSTRY

The frequency with which dermatitis occurs among fishermen and fish handlers makes it the chief occupational hazard in this industry. Numerous investigators have described the various skin lesions of fishermen in different parts of the world. While many of these infections are potentially common to all fishermen specific factors such as climate type of fish handled dietary habits, sanitation type of ship and length of voyage influence the frequency severity and type of lesion.

The range of fishing from the New England ports extends from the Capes of Virginia to the banks off Nova Scotia and Newfoundland. The principal fish caught in these waters are the cod haddock, mackerel, herring rosefish pollock, whiting, sole and flounder. Herring and mackerel swim near the surface of the water and are caught in purse seines, gill nets, pound nets, and in weirs. The other fish are taken mainly by "trawling" or dragging the floor of the ocean with huge cone-shaped nets on long lines, and by gill nets. Salmon are caught in traps, by purse seines and in gill nets. Mackerel are taken by lines, scoop nets, and purse seines, while the

whole catch of sardine is made with purse seines or similar gear Tuna also are taken in purse seines, and by using poles equipped with a short line and a barbless hook As the fish is hooked it is skillfully flipped on the deck and the unbarbed hook disengages itself

Fish may be processed for sale in a number of ways. First, they may be sold in the fresh state either round dressed or filleted Secondly fish may be frozen. In this instance the fish may be frozen as it comes from the water or scaled washed, and either dressed or filleted Fillets are boneless strips of meat which are cut from the body of the fish The fillets are washed packaged and placed in the freezer After freezing they are then ready for shipment in refrigerator trucks and cars. Thirdly the fish may be prepared for canning After the fish are cleaned and washed they are cut into suitable sized pieces or the meat is separated from the bones and packed into cans which are capped sterilized washed in a cleansing solution to remove oil or fragments of fish and labeled Fourthly they may be salted although this is now relatively unimportant. In this case they are split open, cleaned thoroughly washed and packed and salted into "butts" (large barrels) until they are thoroughly cured They are then rewashed and spread out on long racks with the flesh side up to dry in the sun and wind This process is called flaking and requires from a few hours to several days depending on the degree of moisture to be removed After drying they may be immediately packed for shipment or further processed by having the skin and bones removed.

The offal derived from fish is called "waste or gurry and is used primarily in the preparation of fish meal for chicken and animal feed fish oils for animal feeding and industrial uses and glues. This refuse consists of all portions unsuitable for eating such as the head fins tails skins, entrails scales, etc. Some of these manufacturing processes involve considerable handling of the gurry with resulting dermatitis similar in all respects to that from fresh fish

The dermatitis that results from the handling of fish falls into several categories. Dermatitis is frequent and in any fishery a number of cases may be seen at any one time All types of workers engaged may be affected including the fishermen dock or shore workers and fish handlers engaged in processing the fish The salt used in salting the fish is usually handled with the bare hand but unless the individual is suffering from fissures or abrasions, apparently does not cause any dermatitis and in fact, may harden the skin The alkali used in washing the sealed cans to remove oil or fragments of fish occasionally is the cause of a skin irritation While not primarily a skin lesion, Weil s disease occurs frequently in fish workers through infection by an infested rat. Fish cleaners engaged in cleaning and filleting fish are especially prone to abrasion of the skin and may develop the disease, since rats are frequently found in such establishments The disease which is characterized by fever jaundice and hemorrhage under the skin occurs in from four

to nineteen days after infection The diagnosis is usually made by positive serological agglutination tests, since the organism is demonstrated only infrequently in the urine and with great difficulty in the blood

The types of dermatological conditions noted may be grouped in the following classifications

A. *Abrasions Lacerations and Fissures* —These injuries are common throughout the industry since many sharp and irregular objects are handled. Many of the fish have bony spines which lacerate the hands. Fishing gear may also be responsible for cutting the hands.

B *Secondary Infections* —Infection with staphylococcus and occasionally with streptococcus occurs frequently Staphylococcus infection is most commonly seen around the wrists of the fishermen and is apparently due to secondary infection of the traumatized areas from the dirty oilskins. The lesions are called "pigeons" by the fishermen and are characterized by chronicity and induration. They differ in no way from any chronic boil and yield to cleanliness, hot soaks and prevention of further irritation. These staphylococcus infections occasionally also occur along the collar line where the oilskins rub against the skin of the neck and may contaminate any break of the skin

C *Bites and Stings* —Bites have been known to occur from dogfish which may be picked up with a catch and in one instance produced an acute suppurative tenosynovitis. Dermatitis and infection may occur from the various stinging fish which the water may contain The sting of the sea anemone causes redness and blisters in a few minutes, and abscesses may follow The sting of certain rays the jellyfish Portuguese man-of war and sea nettles are some of the other causes of dermatitis in men working with sea water The conjunctivitis which occasionally occurs in workers engaged in washing sardines caught on the west coast is probably due to the presence of portions of jellyfish or strings of sea nettles adhering to the scales of sardines, or to hydrogen sulphide evolved from decaying fish

D *"Redfeed" Dermatitis* —This lesion occurs only in the months from June to September when mackerel are in season. Mackerel feed on minute crustaceans, one of the most common of which is "redfeed" a reddish-orange crustacean occurring in vast swarms. Fish containing these do not keep well after being caught. A few hours later the flesh of the fish softens, and after twenty-four hours the flesh is broken down to the spine. There is also a rapid evolution of hydrogen sulphide from such fish There are other varieties of organisms of a reddish color eaten by mackerel which do not cause such spoilage They are dark red or purple in color whereas the true "redfeed" is orange. This redfeed plus digestive juice from the stomach of the mackerel burns the hand and is sometimes called "cayenne" or "red pepper" After one or more days of exposure to this material the skin of the hands becomes swollen

and intensely red with numerous superficial ulcerations The areas affected are those in contact with the redfeed and occur chiefly along the palms and side of the fingers. The lesion is painful but heals quickly upon application of mild soaks, such as boric acid or dilute epsom salts, followed by boric acid or zinc oxide ointment and avoidance of further contact with the material

On the west coast, dermatitis develops in individuals who come in contact with the skin of the skipjack This dermatitis usually develops about one week after starting work and starts on the forearms above the gloves. Spoiled fish is said to cause more dermatitis than unspoiled ones. The skin of the tuna and the skipjack (skipjack is of the tuna family) is a thin slimy membrane covering the scales which can be easily scraped off with the fingernail and is said to contain a substance which is a primary skin irritant. It will cause dermatitis in anyone working for any length of time with ungloved hands.

Rosefish also called redfish is found in great quantities in Atlantic water and is usually filleted for quick freezing Filleting is a hand operation but may be done mechanically In most instances it is done by a worker grasping the fish in his left hand by the head and then with a stroke of the knife cutting off the boneless material on one side turning the fish on its other side and removing the other strip The rosefish has numerous pointed bones extending back from its head and if the fish is not grasped carefully a puncture of the skin may occur These puncture wounds are in some cases followed by lymphangitis and lymphadenitis which occasionally results in suppuration of the involved glands. For some unknown reason the incidence of rosefish infection has diminished greatly in the past few years.

E *Erysipeloid* —This skin lesion rarely occurs on the Pacific coast, but is very frequent along the Atlantic coast. It is derived chiefly from contact with gurry or the remains of any kind of fish that has undergone putrefactive changes In handling gurry abrasion laceration or puncture of the skin is common and erysipeloid may result. Erysipeloid has been demonstrated to be caused by the organism *Erysipelothrix rhusopathia* and Klauder in an analysis of 100 cases states that 88 were occupational in origin and of these 17 occurred in individuals handling fish

The cases which occur from the handling of fresh fish are usually mild in nature and consist of a localized infection of the fingers and hands There is always a history of injury usually one of puncture of the skin by a fish bone. It has been noted that if free bleeding occurs following such a puncture infection is rare. However if no bleeding occurs almost invariably erysipeloid develops. The disease appears within a period of several hours to one or two days. The lesion is always on the hand and appears first at the site of puncture, and there is moderate pain followed by swelling and redness. The erythema has a distinct purplish hue and progresses down the finger into the web and frequently ascends alongside the

adjoining finger The workers call this type of infection "run around" The progress of the line of redness is slow sharply defined and slightly elevated with involution in the central portion. Swelling may be severe and interfere with function Arthritic symptoms may occur and may persist after the cutaneous lesions have disappeared but this is rare.

Klauder and others have reported cases of generalized infection which were in several instances followed by death This occurs very rarely in those who handle and process fish soon after they are caught. The original site of puncture occasionally suppurates very slightly and in some instances a drop of pus may be evacuated. Vesicles described by others have not been noted in our cases. Lymphangitis is frequent, and many of the workers complain of pain and tenderness along the arm and forearm although enlarged lymph glands are palpable only in a few instances. In one severe case which extended above the wrist, slight constitutional symptoms were noted which consisted of a mild rise in temperature to 99.5° Fishermen, a hardy group of workers rarely stop work on account of symptoms.

F *Skin Cancer*.—Individuals exposed to excessive amounts of sunlight are apt to develop carcinoma. The frequency of this condition is increased by exposure to tar Fishermen use tar on nets to prolong their life and to impregnate rope cables and tarpaulins. They also have the habit of holding the needle in the mouth while mending nets. The combination of exposure to the tar and sunlight has led to an increased incidence of epithelioma.

G *Allergy*.—Some few workers develop dermatitis because of allergy to fish oils. Such cases usually occur among those handling cooked fish

Treatment.—Treatment of *erysipeloid* consists of first evacuating the organism if possible Fishermen from experience have learned to make bone punctures bleed if they do not do so spontaneously In severe cases the finger may be put in a splint. The treatment used successfully in one plant has been frequent and prolonged chlorine soaks followed by the application of ichthyol ointment. The sulphonamides and roentgen-ray therapy have also been used successfully and in severe cases the use of immune serum may be advisable although we have had no experience with this method of treatment. In some cases the original lesion may become quiescent and after three or four days suddenly become active again In some instances spread of infection may occur even fourteen to eighteen days after the initial infection X-ray examination of the affected parts will show marked soft tissue swelling in the region of the joints, but no bony changes have been noted

The treatment for the *bites of fish* is similar to treatment for snake venom that is the wound is opened and washed with a strong solution of potassium permanganate. The treatment for lesions from sea nettle and jellyfish is to wash the part with a solution of sodium bicarbonate to neutralize the acid contained in these bites.

Treatment of *staphylococcus* and other *secondary infections* should consist of wet soaks and incision and drainage when indicated

Redfeed dermatitis is best treated by boric acid soaks. Rosefish poisoning is treated by incision of the area of bone penetration and evacuation of the suppurative material which may be present. Arm baths using a hot chlorine solution followed by an ichthyol dressing applied to the incised area gives very satisfactory results.

Prevention.—The prevention of dermatitis from fish may be accomplished by the use of rubber gloves. These gloves should have treads on the finger tips to enable the workers to handle the slippery fish. Also they should be of heavy enough material to prevent puncture of the fingers. A light rubber glove may be used if a cotton glove is pulled over it to provide a gripping surface. Two pairs of gloves should be issued to each worker with instructions to wear one pair for half a shift and then wash the gloves with water and permit them to dry for the next shift while wearing the second pair. *If puncture should occur with the bones of the rosefish or gurry* the wound should be made to bleed freely. A small amount of chlorine added to the water used to wash the knives and gloves has proved helpful in destroying contaminating organisms.

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FLORISTS

Nurserymen and florists are subject to many of the occupational diseases that affect agricultural workers and market gardeners (*q. v.*). The outdoor workmen are exposed to the same weather conditions which produce chilblains, fro[illegible] sunburn, urticaria, hydroa aestivale, intertrigo, prickly [illegible]s erythematosus, etc. They are also affected by poison [illegible]her irritating vegetation, and to the bites and stings of in[illegible]. Picking grubs from trees and p[illegible] is a common source o[illegible] gard[illegible] [illegible] cuts and scratch[illegible] the [illegible] stalks, and [illegible] shrubs and flowers [illegible]k. The [illegible]ly become in[illegible] [illegible]phylo[illegible]ococcus. [illegible] [illegible]terized

by nodules and tubercles that often ulcerate is a recognized disease in the countries of southern Europe. (See Bacterial Infections.) Tetanus is not infrequent, due largely to the unfortunate habit of applying earth to bleeding wounds. One fatal case has been reported following the scratch of a rose thorn.

The irritating effects of geraniums, chrysanthemums, clematis, oleander, ground ivy, larkspur, Virginia creeper, box, dwarf laurel, arbor vitae, and numerous other plants and flowers may cause dermatitis among sensitive workers, although the most frequent cause of dermatitis is the widely cultivated primrose. It is estimated that from 30 to 60 per cent of gardeners and florists are sensitive to the sap and pollen of this plant.

Eruptions of the hands and periungual tissues have been reported among packers and sorters of hyacinth, narcissus, tulip bulbs, tulip stems. The whole plant and flower of daffodils and jonquils have produced numerous cases of dermatitis, a condition popularly known as "lily rash." (See chapter on Plants and Woods.)

Acari infest many of the plants handled by florists and cause pruritus.

Sporotrichosis is sometimes reported in this industry. The sporothrix may be transmitted by various plants, especially by the Barberry shrub. It enters the body through any break in the skin. The disease is characterized by cutaneous and subcutaneous nodules, abscesses, and ulcers which tend to group themselves in a line along a lymph vessel. (See Mycotic Infections.)

Cases of actinomycosis and aspergillosis have been reported. Blastomycosis may also be incurred from plants, but appears to be rare in this occupation.

Scopulariopsis koningii may be carried to the skin by manure and straw and cause dermatitis accompanied by intense itching. *Scopulariopsis brevicaulis*, found in decayed vegetable matter, is supposed to produce a vesicular eruption of the hands that often involves the nails.

Débris of plants, earth, and molds which accumulates in the hair and beneath the nails may cause irritation of those areas. Ankylostomiasis has been reported among gardeners.

Manures and fertilizers, both artificial and natural, as well as insecticides, may affect florists in the same way as described under "Agricultural Laborers." Nicotine spray used as an insecticide has caused dermatitis. (See Insecticides.)

A case has been reported of cancer on the hand of a gardener attributed to contact with soot used to destroy slugs.

Prophylaxis consists in the adoption of proper clothing to exclude dampness and cold and the use of gloves and goggles by workers who handle fertilizers and insecticides. Facilities for frequent cleansing of the skin should be provided, and the practice of going barefoot prohibited. Prompt disinfection and protection of wounds, even the slightest scratch, should be carried out. Workers found to be sensitive to plants should be transferred to other work. Gloves

should be worn by persons handling bulbs, or the nails cut very short and the fingers rubbed with soap before beginning work.

ARTIFICIAL FLOWER INDUSTRY

Imitation flowers, foliage and fruit used for house decoration hat and dress trimmings, funeral wreaths etc., are made from numerous raw materials, including paper feathers, shells, metal glass, china wax goldbeater's skin cloth and celluloid.

Of chief industrial importance are flowers designed for millinery The materials used most extensively are caoutchouc waxed silk, cotton cloth glue starch paste rubber solutions, varnishes, coloring matter and wire.

The petals are cut out with a punch either by hand or by machine and are then dipped into a mixture of starch paste and coloring material or the color may be applied with a brush or be dusted on as a powder The pieces are dried in the air or in a drying chamber and are afterwards fluted with a hand goffering iron or in a goffering press. The hearts of the flowers are made of cotton covered with rubber solution and dusted with colored powder The worker fixes in the pistil and petals with glue covers the stalk with a tube of cloth or rubber and mounts the flowers on a thin wire. To produce a dewy appearance the leaves are coated with a liquid and then dusted with finely sifted glass or crystal powder This is a hazardous operation due to the fine silicious dust and to the possible presence of lead compounds in the glass.

The dry colors not being fixed by a mordant also give off dust during manipulation especially in the mounting of leaves and petals on the wire stem.

Artificial fruit is made of wax gelatin hollow glass colored from within cotton covered with cloth or of colored celluloid

In making porcelain flowers and fruit, the parts are cut out of china paste and formed with molds and suitable implements into their final shape colored with vitrifiable paints, mounted on wire, and baked in an enameling oven (For risks, see Potters)

Natural flowers are sometimes dried and used for the same purposes as artificial flowers, in which case the stalks are treated in the same way as the artificial product.

The hands of the workmen in this industry are often affected by the mechanical operations alone. For example, a thinning of the epidermis has been observed among women who make the bouquets and the constant repetition of small motions sometimes causes bursitis and synovitis Erythema and hyperesthesia of the distal phalanges of the thumb and index finger have been reported and scaling and keratosis often occur at these points

In the past there has been a high incidence of lead poisoning among flower makers due to the use of lead chromates and white lead in the patterns and coloring materials, and of arsenical dermatitis from contact with green colors prepared with arsenic.

Risks, however from these sources have been greatly reduced in late years due to restrictive legislation which has brought about the substitution of aniline dyes. Nevertheless, some hazards are still encountered from coloring materials. Picric acid may discolor the nails and cause irritation of sensitive skins, and the various solvents of aniline colors such as methyl alcohol benzene, carbon tetra chloride, etc may cause dermatitis.

Celluloid which is extensively used in making artificial fruit and flowers, exposes the workmen to accidental burns when the substance becomes ignited and to dermatitis from various solvents used for it. Chrome colors used for celluloid may produce ulcers.

Workers suffer irritation of the mucous membranes of the eyes, nose and throat from siliceous dust which arises in powdering leaves with glass.

Rubber solutions and varnishes are other potential sources of skin disease in this industry

The United States Department of Labor lists the industrial skin hazards to which artificial flower makers are most exposed as follows bursitis, synovitis, chronic localised inflammations, arsenical dermatitis chromium ulcers, lead and mercury poisoning and dermatitis from methyl alcohol.

FLOUR AND GRAIN INDUSTRY

Reports from modern well-equipped flour mills reveal an exceptionally low rate of morbidity among the workmen. Silos for the storage of grain form an integral part of such plants, and pneumatic apparatus increasingly supplants the methods of the old-fashioned grain elevator A system of filters, separators, and sorters mechanically eliminates impurities and débris from the grain, while exhaust ventilation greatly reduces the hazards from dust.

In the older types of mills, including wind and water mills, the risk from accidents is relatively high due to the care of wings, blades, wheels, and millstones.

Explosions of flour starch and rice dust are a source of danger in grain mills and elevators. They may occur in the process of grinding when the stones are placed too close together heat is generated and sparks from friction of foreign bodies with the stones are capable of igniting the dust. Even in modern plants static electricity and metallic débris in the flour constitute a danger of explosion which may result in burns among the workmen.

Dust from grain, especially oats is more irritating to the respiratory organs than flour since it is likely to contain particles of earth millstone, iron straw husks, and other injurious foreign material Hay fever is a hazard to allergic persons. Sporotrychosis has been observed among shovelers of barley and is due to the presence of *Aspergillus fumigatus* and *Mucor mucedo* in the grain. A report from a Leningrad flour mill in 19[illegible] has stated that respiratory affections such as rhinitis, pharyngitis, laryngitis, and chronic

catarrhal otitis occur among approximately 50 per cent of the older workers.

Threshers and polishers of grain as well as those employed in hammering the lids on barrels or in sacking the flour frequently suffer from epistaxis and nasal catarrh. Flour and meal dust when inhaled in great quantities adhere to the mucous membranes in thick crusts which may cause ulceration and atrophic rhinitis. The dust also affects the external ear by mixing with the wax becoming packed against the tympanum and causing partial deafness, eczema or furunculosis of the external meatus. Irritation from both cereal dust and flour may cause conjunctivitis and blepharitis.

In the handling and dressing of millstones, injury often occurs from splinters and serious affections of the respiratory system result from the stone dust. (See Stone Industry.) A form of itch is often observed among the older workmen and is due to penetration of the epidermis by particles of iron, steel and stone liberated in the processes of dressing and polishing. The lesions consist of blackish gray spots on the backs of the fingers and hands and on the radial surface of the forearms.

Cutaneous eruptions on the hands and forearms are frequent among millers. They may be urticarial or eczematous lesions which tend to form rhagades. Dirt and dust lead to the formation of boils, acne, paronychia and in some cases phlegmonous erysipelas.

Millers who sort, clean, and carry grain are subject to pruritic eruptions caused by acari such as the *Pediculoides ventricosus*, *Sphaerogyna cerealella*, *Tyroglyphus farinae*, etc. The latter, which sometimes infest wheat from Russia, may cause respiratory affections as well as violent but transitory eruptions of the skin. Dermatitis due to acari has also been reported among weighers of grain.

An erythemato-papular eruption which later became vesicular and pustular has been reported from Italy in a workman who handled rice infested by *Pediculoides ventricosus*. The disease was accompanied by coryza and loss of weight.

Mill workers, longshoremen, agricultural laborers, and others who carry sacks of grain or flour on the shoulder are frequently affected by an itchy dermatitis on the sides of the neck in contact with sacks infested by acari. Epidemics of acariasis have been reported among these industrial groups. The mites may also be transmitted to handlers of used empty sacks. (See Insects and Animal Parasites.) A similar condition has been observed in malt houses in Great Britain (see Breweries) and had been attributed to the mold *Rhizopus nigricans*. In flour mills a form of itch similar to "baker's itch" has been observed (see Bakery Trade) which is not due to acari.

Actinomycosis, blastomycosis, and sporotrichosis have been caused among workmen in mills, silos, and grain elevators by infected grain and chaff.

A "rice poisoning" in a California rice factory was described in 1925 by Alderson and Rawlins. It consisted of erythema, purulent

folliculitis, and diffuse eczema which became secondarily infected. The lesions were localized to the hands, wrists, neck, and chest of workmen who handled the "paddy" rice prior to cleaning, and did not occur among the polishers. No acari were present in the rice, and the etiology was not definitely established. The action of silica in the "paddy" was thought to be a possible cause while impurities such as manure in the grain and lack of personal cleanliness were believed to be contributory.

FIG. 1[illegible].—Dermatitis from wheat chaff in a mill-wright. (Case of Drs. Foerster and Wieder.)

Cases of poisoning may occur from the improper use of hydrocyanic acid gas for destroying maggots in flour, from sulphur dioxide or chlorine containing nitrosyl chloride used to bleach flour. The latter may also cause irritation of the skin. Such cases are generally due to accident, negligence, or defects in the plant.

GLUE MANUFACTURE

Glue compositions vary widely. They may be roughly classified as (1) Protein (casein or gelatin) glues, (2) natural resin glues, (3) synthetic resin glues, and (4) combinations of the foregoing.

Gelatin glues are manufactured from animal débris, including skin intestinal tissue horns, hooves, and bones obtained from slaughter-houses, butcher shops and tanneries also from old gloves, parchment, and scraps of leather from which the tannin has been removed Fish glue is made from the offal of cod and other fish (skin cartilage clippings etc) discarded by fish canneries.

For making glue from skin the hides and skins are treated by steeping in slaked milk of lime for two to six weeks a process known as liming to remove any blood or flesh that may adhere and to form a lime soap with the fatty matter The lime is afterwards removed by an acid such as juice of sour tan or dilute hydrochloric acid or the carbonic acid of the air Although the solution can then be gelatinized by drying in the air it is more commonly steamed in an autoclave and afterwards boiled The liquid is concentrated decolorized with sulphur dioxide sodium hyposulphite or hydrogen peroxide then clarified and run into troughs to cool in the air or in cold water where it solidifies into gelatin The blocks of gelatin are then sliced and dried over screens in chambers heated to 20° to 30° C or in hot-air drying tunnels.

To make bone glue the bones are cleaned with hot water and broken up in grinding machines or cylindrical fluted rollers. They are defatted by various methods, one of which is by boiling in Scottish shale oil and natural petroleum

Alimentary gelatin is extracted by hot water in an autoclave under pressure or by hydrochloric acid which converts the tricalcium phosphate of the bones into soluble monocalcium phosphate Lime is then added to precipitate bicalcium phosphate which is used for artificial manure or for the manufacture of phosphorus and the insoluble osseine is boiled to make glue by the procedures described for skin glue

A pure edible gelatin is produced from the sounds or air bladders of fish while ordinary glue is made from all kinds of fish offal The raw material is thoroughly washed and discharged into extractors with live steam After digestion the liquor is run off and allowed to stand The oily layer that rises to the surface is removed and the lower gluey part is clarified with alum The liquid is then filtered concentrated in open vats, and bleached with sulphur dioxide The unpleasant odor and taste of this glue are removed by boiling in a 1 per cent sodium phosphate solution containing 0.25 per cent of saccharine

The above processes produce glue in solid blocks which may be sold in this form or may be pulverized or liquefied by warming and adding a reagent that destroys its power to gelatinize. For this purpose the following substances are employed Acetic acid magnesium chloride hydrochloric acid and zinc sulphate nitric acid and lead sulphate or phosphoric acid and ammonium carbonate

In order to obtain a waterproof glue linseed oil varnish and litharge may be added to the basic material or resin may be dissolved in a hot solution of glue and water and afterwards diluted

with turpentine. Dissolving glue in water and adding $\frac{1}{10}$ part of potassium bichromate is another method. Alcoholic solutions of various gums and also tannic acid are sometimes employed for this purpose.

Marine glues that must be entirely impervious to water are made of solutions of India rubber shellac, asphaltum, or mixtures of these in benzene or naphtha. Instead of India rubber sodium tungstate and hydrochloric acid may be added to a strong glue solution.

Another glue that contains no gelatin can be made by heating linseed oil with 8 parts of quicklime. When this is cold it forms a hard mass that melts on being heated.

White, or Russian opaque glues are obtained by adding to strong glue such white substances as lead sulphate or carbonate, or zinc white. Another type of glue results from concentrating good glue to a paste and adding 0.1 part of powdered sugar and citric acid. Mastic glue used for repairing glass and china, is made by mixing glue with some adhesive substance such as turpentine and starch.

Pastes serve some of the same purposes as gelatin glue but are mainly applied to paper labels etc. The simplest type is produced by an emulsion of flour or starch in hot water. Casein glue is a paste made of casein and water to which is added a hot concentrated solution of sodium hydroxide or sodium bicarbonate borax, sodium tungstate or ammonia.

Vegetable glues are water solutions of gum of acacia, elm salep sassafras pith or tragacanth. These are employed chiefly as thickening agents in the printing of cloth. Others have a mucilage base obtained from seaweed.

Glues are widely employed in industry for cabinet making, joinery and marquetry in the manufacture of paper cartons, gummed labels, envelops, etc., and emery paper cloth in the manufacture of inking rollers and copying pastes in multigraphing in the manufacture of hats and the preparation of paints for making court plaster or sparadrap and impermeable tissue and with certain modifications for innumerable other purposes. For bookbinding ordinary glue solution is mixed with glycerine and dehydrated by heating. For mounting photographs the glue is dissolved in alcohol and glycerine added. But few cases of dermatitis have been reported from gelatin and natural resin glues. The casein glues have caused dermatitis because some of them are strongly alkaline.

Synthetic resin glues cause many cases of dermatitis. The following synthetic resins either alone or in combination with each other or with natural resins, may be used as liquid cold glues, thermal setting glues, or molding powder glues. Cumarone, polyvinyl esters, ethyl esters, methyl esters, cellulose esters, cellulose nitrate alkyd dicyanodiamide urea-formaldehyde phenolformaldehyde.

In the manufacture of synthetic glues catalysts are often added. For this purpose mineral acids (HCl or H_2O_4S) alkalis (NaOH KOH CaO NH_4OH etc.) zinc oxide, potassium cyanide hydra-

zines amine hydrochloride sodium ethyl sulphate alkyd resins and dicyanodiamide resins are employed The completely polymerized or cured resins rarely cause dermatitis, but completely polymerized resins can seldom be used as glues The incompletely polymerized or partially cured resins are the ones most used as adhesives and these contain the incompletely combined irritant chemicals which can and do cause dermatitis. The addition of the catalysts, many of which are themselves primary irritants increases the skin irritant properties of resin glues.

The urea formaldehyde and the phenol-formaldehyde resin adhesives are the ones found to cause most of the dermatitis in the factories inspected in the course of this study

The urea-formaldehyde resins may contain thiourea or may be modified with furfural acrolein alkyd ketone phenol resins etc.

The phenol-formaldehyde resins may contain cresol naphthol catechol resorcinol xylenol (tar acid) and salicylic acid combinations with formaldehyde or with butaryl, benz acet and paraldehydes These combinations may also be chlorinated They may be modified with any of the other resins mentioned above.

To determine the irritating chemical radical causing the dermatitis the actual composition of the resin and the stage of polymerization should be known before patch tests can be performed intelligently This information must be obtained from the manufacturers as chemical analysis often fails in this respect.

In *previous studies on resin molding powders it was found* that formaldehyde was the chief irritant in these powders, being responsible for about four-fifths of the cases. The phenol fraction was responsible for the remainder Hexamethylene tetramine which is present in many of the molding powders to supply the additional formaldehyde needed to complete the cure in the mold, is not present in the glues. But since formaldehyde is present in the urea and phenol-formaldehyde glues the absence of hexamethylene tetramine does not deprive them of their skin irritative properties. The presence of phenols and formaldehyde in the glues can often be detected by the odor

The resin glues are used in the manufacture of plywood fiber board laminated asbestos, glass cloth tool handles and partitions for coating paper and fabric to be used for adhesives, and for many other purposes.

They are used in powder form paste form, in solution, and as cold glues, or thermal setting glues (with the addition of pressure)

That these glues are primary skin irritants if they come in contact with the skin in sufficient concentration has been proved by twenty four-hour patch tests on several controls.[1] That these glues are also sensitizers is proved by the fact that the workers having dermatitis *react more rapidly to patch tests than do the controls,* as well as by the fact that about 50 per cent of the affected workers, if they are

[1] Controls often show delayed reactions appearing 24 to 72 hours after removal of the patch.

permitted to work while undergoing treatment, develop a tolerance to limited contact with the glues containing comparatively weak concentrations of the irritant chemicals.

In making plywood for planes and gliders those who apply the cold liquid glues to the edges of the sheets of wood and those who apply the glue tapes (Tego) to the surface of the panels to cover defects are the ones most likely to be affected with dermatitis. The parts most often affected are the palms where they contact glue-soiled brush handles and spatulas the dorsum of the hands, from glue-soiled washing solutions and glue-soaked sponges, and the forearms which are touched with glue-soiled fingers and tools. Those who work without stockings while shaping the panels in the molds often develop dermatitis on the legs where the glue touches the skin.

In some cases dermatitis begins as early as the third day after exposure (the primary irritant effect of the glue) while others may be exposed several weeks before dermatitis occurs. No doubt the degree of exposure to the glues and the personal cleanliness of the worker are the main factors determining the time of onset of dermatitis.

Those working on the presses, which heat and press together the sheets causing them to adhere and form plywood are only occasionally affected These workers are subjected mainly to the fumes of formaldehyde coming off the presses and only occasionally to contact with the uncured glue.

In factories where plywood propellers and other rigid parts are made, the contact is somewhat different. Here the pieces of veneer are impregnated with liquid resin glue by dipping them into a vat and then placing them in a pressure chamber The workers at this operation are exposed to strong fumes of formaldehyde and to splashes of liquid Unless properly protected these men will develop dermatitis, conjunctivitis, and irritation of the respiratory tract. Those engaged in mixing the glues are similarly exposed Workers who machine, sandpaper and polish plywood are exposed to wood and resin dusts. Some of the plywood is machined before the resin glue is completely cured and at such operations there is more dermatitis than at operations where the completely cured resin dust is encountered

In factories where glass cloth is made into tool handles and translucent partitions, workers thought the glass fabric was the cause of the dermatitis, but patch tests showed that the condition was caused by phenol-formaldehyde molding powder which is spread on the fabric before it is placed in the hot pressure molds. The operation of placing the molding resin powder on the cloth should be performed in such manner that the resin powder does not come in contact with the worker

The principles of treatment of dermatitis caused by the glues are the same as for any other form of contact dermatitis. In the acute stages where there is edema vesicles, and oozing only soothing wet

dressings should be used such as boric acid solution Burow's solution and tannic acid solution 3 to 5 per cent this last on parts other than the face or neck. In the latter stages when the eruption begins to dry and crust the use of mild fatty base ointments such as boric acid ointment, calamine ointment, or zinc oxide ointment should be used The use of phenols for antipruritic purposes should be avoided because they may increase the dermatitis. If complications such as infection set in special treatment may be required Workers with mild cases should be given protective clothing and should be treated on the job in order to give them the chance to become hardened (if the dermatitis is caused by allergy) and to learn how to protect themselves (if it is due to primary irritation)

To prevent dermatitis among workers with resin glues, the management should first of all provide suitable exhausts to draw away from the workers all irritant dusts or fumes coming off the operations. The management should provide daily clean coveralls for all workers exposed to irritant glues, dusts, and fumes.

Workers who apply the glues to the veneer should be provided with impervious gloves made either of washable leather or fabric-lined rubber and sleeves and aprons of impervious materials. The sleeves should fasten over the gloves at the wrist to prevent irritants from falling into the gloves.

Facilities for washing the hands with soap and running water should be installed at strategic places so that the workers can frequently wash glue from the gloves and skin The brushes and sponges used for glueing should be washed or changed about every two hours and workers should be cautioned against touching the face and other parts of the body with glue-soiled fingers, gloves, or tools.

Sufficient shower baths should be provided for workers, and they should be compelled to take showers after work. Sufficient time should be allowed for this and the workers should be paid for the time.

Protective ointments or applications are not necessary if these precautions are observed but if they are used they should be furnished by the management and should be used in addition to all of the other preventive measures. The type of applications best suited to prevent glues from touching the skin are either those of the water insoluble invisible glove type or of the water repellent fatty type described (as type 2B and type 3 respectively) (See Protective Ointment.)

GARAGES AUTOMOBILE REPAIR SHOPS CHAUFFEURS

Diseases of the skin are common among workers in garages, service stations, and repair shops due mainly to the oil grease and solvents with which the hands body and clothing are contaminated

Those who inspect and repair engines are especially exposed to dermatitis from accumulations of grease and dust on the hands

which are often the site of cuts and abrasions incurred in the work. The resulting lesions vary with the kind of oil used. Petroleum oils tend to cause an itching acneform eruption. (See Petroleum.) Where washing facilities are not easily accessible the oil and dirt left long on the skin increase the irritation and the situation is only made worse by resorting to solvents such as benzine or gasoline for cleansing. These substances themselves are skin irritants. Dermatitis has frequently been reported from washing in or otherwise handling kerosene, benzine or gasoline. In one case the repeated application of gasoline has provoked a local dermatitis later generalized over the body.

FIG. 170.—Sensitization dermatitis from oil-soaked clothing.

Continued contact with oils and greases frequently gives rise to a folliculitis of the fingers and forearms which may develop into furunculosis.

Auto washers may develop a dermatitis of the hands from continued contact with soap solution used in the work. Dermatitis has been reported from the tetra-ethyl lead added to make anti-knock gasoline. The tetra-ethyl lead is added to gasoline in the

proportion of about 1 to 1 400 Gasoline itself is a primary skin irritant and it is difficult to conceive how the addition of such a small portion of another chemical can add appreciably to the irritant properties of gasoline itself The fact that tetra-ethyl lead gasoline may cause lead poisoning is another matter and is an established fact.

The use of methyl alcohol in antifreeze solutions may cause skin lesions, but constitutional symptoms from this source are rarely reported

Solvents contained in the various patented liquids and pastes now used to wash and clean automobiles are likely to cause dermatitis. Potassium cyanide, often employed to clean the metal parts, may produce ulceration of the skin An acneform and papulovesicular affection of the hands and forearms observed in a cleaner has been attributed to contact with impure petroleum.

Radiant heat from the forges of repair shops exposes the smiths to high temperatures. The process of autogenous welding calls for special glasses or screens to protect the eyes.

Chauffeurs are exposed to many of the risks enumerated above but to a lesser degree. They come in contact with gasoline benzine kerosene, etc. with lead tetra-ethyl in gasoline, methyl alcohol in antifreeze and poisonous fumes from the exhaust. They do not however handle grease and oil sufficiently to injure the skin.

While driving a car at high speed strong pressure of air against the eyeballs may cause conjunctivitis and blepharitis.

An affection of the heel known as *Talon douloureux* is sometimes experienced by drivers on the day following excessive use of the pedals. The pain is due to overstrain of the plantar fascia caused by keeping the foot in dorsiflexion for long periods with only the posterior edge of the heel resting on the floor Serous bursitis over the tendon of Achilles has also been reported from this cause.

In all automobile work poisoning by carbon monoxide should be guarded against by adequate ventilation of garages and workshops.

GAMEKEEPERS, TRAPPERS AND HUNTERS

Dermatitis due to early degeneration of the skin from exposure to heat, cold and wet is common in these occupations. (See chapter on Physical and Mechanical Agents.) The workmen are also exposed to irritating plants such as poison ivy poison oak, etc. (See chapter on Plants and Woods.) They are especially subject to the stings and bites of mosquitoes, ticks, spiders, bees, wasps, wild animals, snakes vipers, toads salamanders etc. which may result in dermatitis or infections. Tetanus may occur through infection of wounds with contaminated soil etc. Scabies may be spread by unsanitary living conditions in the rough-and-ready huts generally inhabited by hunters and trappers.

Myiasis may be caused by the larvae of flies, and other insects. Scabies is contracted from many wild animals and birds and from

the dogs which almost invariably accompany hunters, trappers, and gamekeepers in their work. One case has been reported in a huntsman from skinning a diseased fox.

Trombidiosis may be caused by chiggers living on weeds bushes, and on some wild animals (moles, hedgehogs, etc.) Ticks on vegetation wild animals, and dogs may serve as intermediaries for infectious diseases. Rocky Mountain spotted fever is transmitted by ticks, and tularemia by rabbits, other wild game, and by the bites of ticks and deer flies. This occurs during the hunting season especially among persons who dress animals.

The fox moth and Chenilles processionnaires which are abundant in pine forests, produce irritation of the skin by their barbed hairs and sometimes by their cocoons.

Birds and pigeons are often infested with ticks and lice (*Argas reflexus* and *Dermanyssus avium*) which cause an itch among human beings. Bites of *Lepoptena cervi*, which live on large game such as deer roe deer and wild boar during the month of September result in hard pruriginous papulæ which appear the following day and may last for two weeks. (See chapter on Insects and Animal Parasites.)

Trichophytosis is sometimes transmitted by birds, dogs, deer and other animals and other fungous infections by plants and decaying wood (See Mycotic Infections.)

Workers in these occupations are subject to traumatic injuries from firearms, traps, horns and hooves of animals, scratches from *claws of animals and birds as well as from their bites.*

GARMENT AND MILLINERY INDUSTRIES

The manufacture of clothing has become a highly organized factory industry in the United States, with the unhealthful sweat shop of earlier times practically extinct. In the year 1911 reforms were instituted, and between that year and 1924 more than 60,000 physical examinations of garment workers made at the Union Health Center in New York failed to reveal more ill-health than existed among employees in similar industries and only a few special occupational diseases were found.

While the incidence of dermatitis is not high certain hazards exist for example, from dyes and chemicals in the materials, from solvents used in cleaning from burns during hot pressing and from infections largely due to careless habits among the workers themselves.

Dyes and other irritants, when activated by perspiration or dampness and heat, may cause dermatitis. (See Dyes.) Knowles has reported 16 cases of *dermatitis from dyed materials among tailors* 10 among apprentices, 4 among shirt makers, 4 among hot pressers, and 1 in a tailor's foreman. In the opinion of R. Prosser White however the mordants and other chemicals in the cloth not properly washed out or neutralized are more likely to be the causative agents. Deep ulcerations *and other lesions of the skin* have resulted from

contact with mordants such as salts of chromium iron tin antimony aluminum lead zinc and copper

Occupational infections in the form of extragenital syphilis tuberculosis, sore throat etc. which occur in this industry have been attributed to the habit of holding in the mouth pins and thread that have been used by others These are often picked up from the floor and used without being sterilized Pricks from infected pins and needles may also be the means of inoculation with harmful bacteria. Erysipeloid has been reported by Reisch as occurring occupationally in a dressmaker

Even with the best of mechanical equipment some parts of garments must be sewn by hand and the faulty posture assumed for hand-sewing has been responsible for certain lesions among tailors. Swellings containing serous fluid have been observed over the external malleolus and the fifth metatarsal due to constant pressure of these parts against the work table Callosities sometimes occur in the sacro-ischiatic region and white tumors over the pelvic joints have been reported by Hahn Callosities on the left index finger often result from pressure of the needle

Pressers develop callosities on the palms and fingers of the right hand which holds the iron They also incur frequent burns both from the irons and from hot vapors given off by the damp materials.

Milliners who varnish straw hats sometimes develop dermatitis from solvents such as turpentine benzine methyl alcohol carbon tetrachloride and benzol. Some varnishing preparations used for this purpose have been found to contain as much as 92 per cent of benzol Garment workers also come in contact with these solvents in cleaning fabrics that have become soiled by machine oil and other substances in the course of work

GROCERIES AND DELICATESSENS

Occupational dermatoses among retail grocery and delicatessen workers are not frequently reported at the present time A large part of grocery stock is received in packages and bottles and requires no direct handling

In stores where sugar cereals cheese dried fruits meats, and cocoanut are sold from bulk mites of the Tyroglyphus family present in the foodstuffs may affect employees with a violent but transitory form of itch The condition has been observed often enough to gain the title of grocer s itch The sugar mite infests old-fashioned brown sugar which is no longer sold to any great extent.

Damaged dried fruits such as figs, dates decayed onions, potatoes and other garden produce may contain molds or acari which cause dermatitis. (See chapters on Insects and Animal Parasites and Mycotic Infections for possible pathogenic agents.)

Delicatessen dealers usually obtain their meats and other foods already cooked from a central supply house, but when the work is

done on the premises, the employees are exposed to the same risks as have been described for cooks. (See Hotels and Restaurants.)

HOTELS AND RESTAURANTS

The custom of eating meals at hotels, restaurants, lunch counters, etc. has tended greatly to concentrate and increase the handling of food in these centers. Mass preparation and dispensing of food is carried on to a far greater extent in the United States than in any other country. For this reason occupational dermatoses among employees in this industry have assumed large proportions compared with former times.

The situation has created the problem of determining which substances handled in the work are capable of producing cutaneous manifestations. Food preservatives such as boric acid, sulphurous acid, sulphites, boron, salicylic acid, formaldehyde, etc., disinfectants, fungicides and insecticides such as arsenates and copper compounds on fruits and vegetables, coloring matter (coal tar dyes) in pastries, and fruit and vegetable irritants to which the skin may be sensitive, may all possibly cause skin eruptions in this occupation.

Other methods of preserving food, such as salting, pickling with vinegar, salt, or nitre, must also be considered.

Certain risks encountered by cooks, waiters, countermen in cafeterias, lunch rooms and soda fountains (serving light meals), bartenders, dishwashers, kitchen helpers, cleaning women, porters, chambermaids, etc. have already been established.

It will be recognized that the duties of many of these workers overlap in some respects. For example, porters may do cleaning and polishing as well as carry luggage; waiters handle food, cut bread, prepare salads, clean used dishes, etc., and may also be called upon to do some dishwashing, silver polishing, and other jobs not strictly included in waiting on the table; cooks may be required to wash dishes, clean vegetables, polish stoves and utensils, and wash walls and floors; kitchen helpers may assist in cooking as well as cleaning and preparing raw foodstuffs for the cook, scrubbing, washing dishes, cleaning silver, etc.; bus boys wash tables with ammonia and soap powder, polish brass and silverware, oil walls and furniture, clean toilets and washbowls, handle bread, ketchup, uncooked cereals, and canned foods of all kinds; chambermaids in small establishment often help in the kitchen and dining room work. Countermen in lunch rooms and soda fountains and bartenders generally handle some food, wash dishes, clean and polish equipment, and so on.

Thus, many of the risks predominating in one group may be shared to some extent by the others.

Cooks suffer chiefly from the effects of heat. (See Chapter on Physical and Mechanical Agents.) They are especially subject to burns from flames, hot stoves and utensils, boiling liquids, and steam. They may develop *erythema ab igne* from exposure to radiant

heat. Intertrigo and lichen tropicus frequently occur from over heating coupled with excessive perspiration Hydrocystoma may appear on the face and neck from the same cause In women with delicate skins telangiectases are sometimes seen

Lupus erythematosus in cooks is believed to be hastened by exposure alternately to excessive heat and cold from draughts refrigeration etc.

Callosities, excoriations, and rhagades on the palms arise from the pressure of utensils, heat, and humidity

The development of cancer of the tongue and esophagus is encouraged by frequent tasting of hot foods.

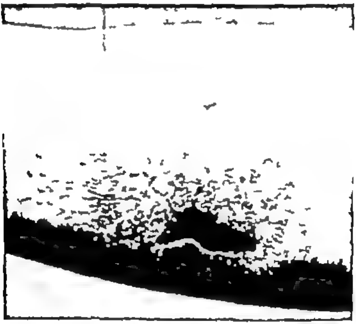

Fig. 130 — Dermatitis in dish washer resulting from the action of hot soap on slight burn

Chancre of the mouth has been noted in a cook from tasting with a spoon previously used by a syphilitic assistant

Open wounds from burns, cuts, and abrasions are very common and infection is likely to ensue

Erysipeloid may result from infection of skin wounds while handling decaying meat but the largest number of cases has been reported from the bites of crabs

Dermatitis of the hands, sometimes affecting the nails can be incurred from the irritant oils and juices of various fruits and vegetables such as asparagus, celery parsnips lettuce fresh figs, etc (See chapter on Plants and Woods.)

Kitchen helpers who clean and prepare vegetables and fruits in large quantities and handle garbage are subject to dermatitis, paronychia, and onychia.

Dishwashers are particularly subject to dermatomycoses of the hands and fingers from maceration, caustic soaps grease, bacteria and fungi. Paronychia due to Monilia and Eroso interdigitalis blastomycetica are frequently seen among these workers.

Cleaners often incur callosities and sometimes bursæ of the knee from kneeling on hard floors, and dermatitis of the hands from caustic substances used to scrub and in polishing metal fixtures and silverware.

Waiters and bartenders are subject to wounds on the hands from knives broken china and glass, etc. These occasionally become infected These workmen are also likely to incur dermatitis from dishwashing metal polishing, and the handling of food and garbage which is often included in their work.

Porters frequently develop callosities and bursæ on the shoulders from carrying heavy weights.

Chambermaids are exposed chiefly to infectious diseases such as syphilis, ringworm etc. from contact with soiled bed clothing carpets and bath room appurtenances.

ICE-CREAM MAKING

In small confectionery establishments the work of making ice cream may sometimes be done by hand but this is now rare except in Naples and Sicily where the hand-made product is considered superior In these places the working hours are often long and the constant use of the hands for a few limited operations results in the formation of callosities which are characteristic of this occupation

A lesion develops on the right wrist at the lower edge of the cubital bone due to friction from the handle of a long spoon used in mixing It is generally oval in shape with a red and rugged surface and measures 2 to 3 cm by 5 to 6 cm. Another callosity 5 to 6 cm wide, and yellowish in color forms on the right palm accompanied by smaller ones at the base of the fingers from the pressure of a short-handled spoon. A flesh-colored lesion occurs on the left hand and turns dark gray when the workman is at rest. This is formed by friction from the handle of the freezer and the color is due to the action of the salt, picked up with the left hand. On the back of the left hand and fingers are smaller transverse callosities caused by slight but constant contact with the freezer while turning the handle.

Contact with salt and ice keeps the nails of both hands worn down at the edges. In those who work steadily for many hours at a time, the whole palmar surface of the hands and fingers may become worn thin.

Chilblains may occur on the hands from low temperatures and contact with salt. Infections of the skin, however are exceedingly rare in this occupation.

In making ice-cream by machinery the entire process of freezing may be carried out without direct physical contact on the part of

the workmen. The mixture is sterilized by heat in large vats or tanks, and passed through a machine called a "homogenizer" or "viscolizer" which breaks up the globules of fat and makes the mixture smooth. The hot mass is cooled by dropping it over a series of pipes containing brine and arranged one above the other. Thence it passes into huge tanks in which a revolving coil keeps the mixture in constant motion. It is placed in containers for freezing which is done by the same method as is used for manufacturing ice. (See Refrigeration.) It is then stored and hardened in a concrete room lined with cork, where a brine refrigerating system maintains a temperature of 10° to 20° below freezing. The cans and molds are shipped directly to the retailer from the hardening rooms.

Ice-cream and ice are usually manufactured in the same plant and the workmen are exposed to similar risks, i. e. inflammation of the respiratory mucous membrane, rheumatism, chilblains, burns, etc. In addition, workers who make ice-cream usually prepare the mixture on the premises and handle large quantities of fruit, nuts, flavoring and coloring materials, sugar, cream, milk, eggs, etc. In this process they are subject to many of the risks enumerated under confectioners and pastry cooks (q. v.). Nevertheless, the incidence of occupational disease in this industry is not great.

INCANDESCENT LAMP MANUFACTURE

Gas Lamps.—Incandescence is produced in a gas, benzine or alcohol flame by the use of a mantle containing metallic oxides that become luminous when heated. The substances may vary slightly but are all based on the original formula of Welsbach.

The best effect is obtained with a mixture of the oxides of thorium (99 per cent) and cerium (1 per cent). Thorium and cerium are derived from monazite sand in which they are present in the form of phosphates. The sand, finely pulverized, is treated with sulphuric acid in a lead-lined tank from which sulphurous fumes are given off and although they may be removed by modern exhaust methods, a certain amount is likely to escape when a fresh charge of sand is put in the vat.

After agitation in the sulphuric acid bath, the product consists mainly of thorium sulphate and phosphate but also contains many metallic impurities and some sulphuric acid. The material is conveyed in lead wagons to a tank made of fireclay where it is purified and the thorium, after many complicated processes, is precipitated as an oxalate by oxalic acid.

The elimination of metallic impurities is done chiefly by hydrogen sulphide (gas or solution). The hydrogen sulphide is prepared in the factory from iron sulphide and hydrochloric acid. The gas, even in small quantities, irritates the mucous membranes of the eyes, nose and throat, and occasional cases of acute poisoning have been reported. Photophobia, bronchitis, anemia, and digestive disturbances are among the symptoms of chronic poisoning with

this gas to which sensitivity is not reduced but rather increased by prolonged exposure.

The solution of thorium oxalate is precipitated by ammonia to form thorium hydrate which is converted into the nitrate by evaporation with concentrated nitric acid

The nitrate of cerium is either prepared in the mantle factory or purchased ready for use It is extracted from the residue in the manufacture of thorium nitrate by solution precipitation with oxalic acid calcination of the oxalate into oxide, and treatment with nitric acid

When the cerite is added to the mass of thorium in the process of treatment, it produces a crystalline acrustation of acid reaction in the vats, whose sharp cutting edges present a danger to the skin and require the use of rubber gloves and clogs by workers who go into the vats.

For making the mantles, a long stocking is knitted or woven of cotton or artificial silk, is thoroughly washed and then treated with a 5 per cent solution of hydrochloric acid to remove such impurities as iron lime, and magnesia. It is then washed with distilled water degreased with ammonia, washed again and dried in a centrifuge.

There is said to be very little risk to workers in the manipulation of the acid baths. However the fabric is sometimes treated with a dilute solution of hydrofluoric acid to remove silicious material and the preparation of the solution from concentrated hydrofluoric acid is a hazard both to the skin and mucous membranes of the respiratory passages.

Danger in operating the centrifugal machine may be eliminated by automatic devices to prevent the motor from starting before the apparatus is closed and to make it impossible to open until all motion has ceased.

The mantle is hemmed and shaped on an electric sewing machine and is then dipped into the solution of thorium and cerium nitrate which may also contain small quantities of aluminum magnesium and beryllium It next passes through a rolling machine which presses out part of the solution but leaves a certain amount still in the tissues. The workers at these machines are exposed to contact with saline solutions unless the hands are protected by rubber gloves.

The mantles are placed on rests and passed into a drier and the upper end is next treated with various metallic salts to harden them so that they may be suspended by an asbestos thread carefully run through the fabric. After application of the hardening materials, the mantles are placed in frames and subjected to gas flames to burn away the organic matter and convert the metallic nitrates into oxides. Further measures are necessary however to produce the required degree of hardness, and the mantles must be treated in a flame of compressed gas to which they are presented either by hand or by machine. This operation subjects the workers to intense ultra-violet and infra-red radiations from which the eyes must be

protected by goggles. The skin may suffer injury from artificial sunburn and other dermatoses produced by intense heat and light radiations. Protection can be afforded by the installation of colored windows in the machine to prevent the passage of ultra-violet rays.

The calcinated mantles are extremely fragile and in order to withstand shocks during transportation they must be dipped in an alcohol-ether solution of collodion, castor oil and camphor. In some countries methyl alcohol and methyl ether are used, while in others only ethylic derivatives are employed. The process of dipping exposes workers to skin and health hazards from the solvents and their vapors, and there is also a considerable risk of fire from the highly inflammable substances. In fact, a serious fire hazard exists throughout the factory due to the numerous gas flames in use and the possibility of accidental escape of gas from the pipes and fixtures.

The high temperatures of the workrooms predispose the workers to miliaria and intertrigo, especially when the rooms are crowded and ventilation inadequate.

Other treatments for the fabric of gas mantles are: (1) Impregnation with a solution of lanthanum oxide 30 parts, yttrium oxide 20 parts, burnt magnesia 50 parts, in acetic acid 50 parts, and 100 parts of distilled water. The acetic acid may be replaced by nitric acid, which causes a powdery ash. When acetic acid is used the residue has a tendency to ball up and leave a vitreous ash. (2) A self-igniting mantle is made from a fabric of platinum wire and cotton thread impregnated with a solution of thorium salts and dried. A mixture of thorium nitrate and platinic chloride leaves, after incandescence, a fire-resisting sponge which is capable to some extent of igniting gas mixtures containing oxygen.

Dermatitis has been reported among workers engaged in dipping the mantles into thorium nitrate solution. Friedlander in 1912 reported a case of generalized eczema in a woman so employed for a period of two years. He reported another case in 1913, in which the dorsa of the hands were affected and there were small patches of eczema on the right forearm. The ends of the fingers were so swollen that the nails appeared sunk into the flesh, and the palms showed ridges separated by deep cracks. Numerous other cases of dermatitis from thorium were observed. The rash generally began with intense redness and swelling of the tissues.

Electric Lamp Manufacture.—Tungsten, of which the filament for electric lamps is usually made, is produced from ore containing tungstic acid. By reduction in an electric furnace at 1100° to 1300° C. the tungsten is obtained in the form of a coarse powder. The powder is converted into a stick by pressure and heat, and then placed in a hammering machine that greatly reduces its thickness. The diameter is further reduced by a process similar to ordinary wire drawing. Colloidal graphite suspended in water and sulphur or organic derivatives of tungsten in colloidal state are used as the lubricants for this purpose.

The thread is calibrated by weighing in a torsion balance. The

substances with which the filament is impregnated must then be eliminated and this is done by placing it in a tube containing a mixture of oxygen and nitrogen and bringing it to incandescence by an electric current.

The bulbs are made in glass factories and contain a high percentage of red lead They are cleaned with dilute acid and the neck is cut to the required length A small tube or stem is fixed to the neck to enable a vacuum to be created The base of the mount consists of a small glass tube flanged for attachment to the neck of the bulb and the glass rod is cut to the desired length for support and provided with two flanges. These operations are carried out on rotating machines equipped with numerous gas jets which produce heat and vitiation of the air in the workrooms.

The flanges are heated by blow-pipe until soft and the supporting wires are then attached The lower wires are of iron and nickel the upper of molybdenum and the leading-in wires are of copper or nickel-iron except for the parts embedded in the glass, which are of platinum The different parts of the leading-in wires are welded together by blow-pipe or electric arc. The supporting stem the leading-in wires, and the flange tube are assembled and placed in a machine where the top of the tube is softened by heat from a blow-pipe and welded to the base of the stem

The final shape is given to the filament by placing it in a gauge and raising the temperature to 1000° to 1200° C Finally it is placed in position on the supporting wires and the bulb closed except for the exhaust tube. The air is then drawn out of the bulb with pneumatic pumps and the vacuum determined by means of a gauge containing mercury To ensure complete elimination of air the bulb is filled with gas (argon or argon and nitrogen) and the lamp closed by melting the exhaust tube with a blow-pipe.

The cap is cemented to the lamp with lime or gypsum mixed with alcohol, and the leading-in wires are welded with a tin solder containing lead

After running through an electric current, the glasses are etched to indicate voltage, wattage etc by means of a liquid containing hydrofluoric acid. In some cases the glass is also made opaque with a dilute solution of hydrofluoric acid.

Steel cylinders containing compressed hydrogen and nitrogen are kept on hand at the factories and extreme precautions must be taken to prevent explosions.

The industrial operations which are chiefly mechanical are carried out almost entirely by women since they require no great muscular strength

The chief hazard in this industry is from the mercury in the gauges which not infrequently break and scatter their contents. The mercury readily becomes vaporized by the high temperatures of the workrooms and may produce mercury poisoning Dermatitis may occur from contact with the substance which should be carefully and quickly collected and handled as little as possible

Respiratory affections may occur from inhalation of the vapors of ether, amyl acetate (often used as a lacquer), methyl alcohol, nitric acid, and hydrofluoric acid. There is also risk of dermatitis from contact with these irritants.

In the process of soldering, lead fumes may give rise to systemic poisoning. Pricks from copper wires may cause infections. Dermatitis is possible from contact with copper, nickel, and cement containing lime. (See these subjects.) Heat in the workrooms favors the development of miliaria. Breakage of glass bulbs is a frequent cause of small cuts, and burns may occur during the soldering and heating operations.

INKS

While dermatitis is said to be fairly common among ink manufacturers and ink users, an examination of 1,700 cases of occupational dermatoses reported in the states of New York and Ohio has revealed only 5 cases attributed to the manufacture of ink.

Inks vary in composition according to the purpose for which they are intended. Black writing inks are usually made by adding a slightly acidified solution of ferrous sulphate to a solution containing a dye such as logwood or indigo to make the writing more visible. A small amount of gum or resin is also added to make the ink adhere to the paper and about 1 per cent of phenol is added as a preservative.

Gallic and tannic acids used in ink manufacture are obtained chiefly from nut galls, which are morbid growths on the leaves of various kinds of oak caused by the sting of the gall wasp, although Chinese and Japanese galls are produced on species of Rhus by the action of small aphids. Other sources of tannic acid are "knoppern" (misshapen brown masses produced in immature acorns by the gall wasp), tan bark, sumac, cutch, fustic, quebracho, divi-divi (fruit of the *Caesalpinia coriaria*) and myrobolan (the dried fruit of various species of *Indian terminalia*). The galls are usually boiled in water and the gum is added. When cool, the ferrous sulphate, indigo, and phenol are added and the mixture thoroughly stirred.

Idiosyncrasy to any of the materials may result in dermatitis because the hands and arms of the operators are usually stained with the ingredients of the ink. However, most of the dermatitis is caused by the methods employed by the workers to remove inks from their hands after work. The use of strong alkaline grit soaps, calcium chloride, and stiff brushes are frequent causes of dermatitis. Instead of the above irritants, the use of liquid green soap mixed with sawdust has been advocated by W. J. McConnell for the removal of inks from the hands.

A typical formula for black ink taken from "Ink Manufacture," by Sigmund Lehner, is:

Galls	100	Alum	12
Logwood	30	Ferrous sulphate	45
Dextrin	40	Soft water	1000

Some black inks especially those used for printing may contain potassium chromate usually mixed with logwood extract.

Colored inks are usually aqueous gummy solutions of aniline or natural dyes Red inks contain such dyes as eosin fuchsine redwood or cochineal blue inks, methylene blue or indulin violet inks methyl and crystal violet and green inks, malachite green.

A typical example of a colored ink containing aniline dye taken from Sigmund Lehner s book, "Ink Manufacture" is as follows

Methyl violet	10	Oxalic acid	2
Sugar	10	Water	980

Inks such as copying inks which must dry slowly usually contain a *hygroscopic substance such as sugar* dextrin glucose calcium chloride, or glycerine A sample formula for copying inks is

Logwood extract	70	Alum	20
Vinegar	1000	Gum	25
Water	1000	Sugar	60
Ferrous sulphate	40	Glycerine	4–6

Printing inks usually contain driers such as turpentine or turpentine substitutes. In addition they may contain chromates.

The presence of chromates in printing inks may cause dermatitis among those who come in contact with them and may also cause chrome ulcers, although they are exceedingly rare in the printing trade. It is the driers in the inks which are more likely to cause dermatitis especially if the driers consist of petroleum distillate substitutes for turpentine.

Dermatitis has occurred from the use of cashew nut oil used as a vehicle for printing ink.

Prevention.—Ink makers and others coming in intimate contact with inks should rub animal fat such as lanolin or vegetable fat such as linseed oil castor oil or olive oil into the skin before commencing work. This helps in the later removal of the ink from the hands. After work they should again rub the hands with the same fat or oil and then wash with the mixture of liquid soap and sawdust as recommended by McConnell.

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JANITORS

The duties of janitors are so varied and the substances with which they may come in contact are often so unpredictable that it is difficult to mention all the possible causes of occupational der

matitis to which these workers are subject For example the authors have observed rhus dermatitis in a janitor incurred while clearing away some discarded plants with which poison ivy happened to be mingled Burns from sulphuric acid accidentally spilled while refilling fire extinguishers have also been noted although such work is not normally a part of the janitor's duty

His work generally includes the collection and emptying of garbage cleaning drains, stoking the furnace making minor repairs on plumbing and sometimes on electric wiring replacing fuses, sweeping the premises removing snow and ice from the sidewalk polishing brass, etc. In some instances gardening is included and even though the plot be small there is some risk of dermatitis from scattering fertilizer and insecticides and in caring for ornamental shrubbery notably arbor vitae and hedges of boxwood whose sap is an irritant to sensitive skins.

Folliculitis and septic wounds are perhaps the most common skin diseases of these workers, and are due to contact with decomposing organic matter and dirt of various kinds. Wounds are frequently received from bits of metal rusty nails, and wire and burns from the furnace or electric wires.

Bites from rats and insects are a risk in old buildings, as are also the various rat and insect poisons containing arsenic, thallium etc. (See Insecticides.) Soldering lead pipes in old-fashioned plumbing carries the risk of lead poisoning

In cleaning and polishing brass railings, door knobs and plates and other brass or metal fixtures contact with the polishing materials which often contain such irritants as benzene hydrocyanic acid and oxalic acid may cause dermatitis.

When an apartment left in bad condition is being prepared for a new tenant the janitor may be called upon to clean the stove. In this case the separate sections are immersed in a strong solution of lye and allowed to stand until all grease and dirt are removed Contact with the solution may cause dermatitis unless rubber gloves are worn during this operation

While clearing up the rubbish discarded by tenants the possibility of contact with infected material old razor blades, broken glass, and irritating chemicals is almost limitless and in dealing with skin diseases among these workers it is necessary to make a searching inquiry into all their recent activities and all the material handled

JEWELRY AND ALLIED INDUSTRIES

Precious Metals.—The metals most extensively employed in the manufacture of jewelry are gold silver platinum and brass. These metals *per se* do not cause dermatitis but skin lesions occur from contact with materials used in their treatment and manipulation and from exposure to extreme heat in many of the processes.

The work of the goldsmith silversmith and jeweler includes numerous operations that are carried out partly by machinery and

partly by hand such as melting casting forging rolling pressing filing planing polishing soldering welding galvanizing engraving engine-turning chiseling etc The machinery used includes power presses foot presses, stamping machines, rolling mills large and small lathes milling and grinding machines planers, grindstones small sand blasts, emery and cotton wheels. Traumatic injuries of the fingers are not infrequent in operating the machines

Platinum is dissolved in aqua regia (nitrohydrochloric acid) as the chloride together with the chlorides of iridium rhodium and palladium. Ammonium chloride is added and chloroplatinate of ammonium is separated When heated this deposits a spongy platinum which is made compact by melting in a refractory crucible. When gold is present, the mass is subjected to an amalgamation process to separate the metals.

In the wet method described the aqua regia liberates irritating acid fumes and also at times fumes of osmium. Purification of platinum by the dry method consists of heating the ore with lead and galena and the workmen are exposed to the risk of poisoning from the fumes of lead

A case is recorded of a worker in contact with small quantities of platinum-oxide of ammonia and nitroxide of platinum. He developed burning and itching of the fingers and face and subsequently erysipelatous patches on the skin Eczema of the hands and fore arms and lesions of the nails have been reported in other cases from contact with oxide of platinum

Goldsmiths and jewelers use gold and silver in the form of ingots, metal sheets, plates, leaf etc. Jewelry is manufactured from a basis of "flat stock made by uniting bars of gold with bars of brass of the same width by sweating with silver solder in a gas furnace. The bars are then rolled to the desired thickness and from this flat stock, tubing and wire for bracelets, watch chains and other jewelry are made The patterns for flat ware are struck by a steel die and cut out in steel presses The parts are then soldered together and cleaned in a solution of sulphuric acid polished with cloth wheels and bristle brushes, and finally finished with a weak solution of potassium cyanide and gold applied hot.

Exposure to intense heat in refining silver gold and platinum in preparing the flat stock, and in soldering the various parts, is apt to produce eczema which is not uncommonly seen among goldsmiths and jewelers.

The precious metals are seldom used in pure form but are mixed with small percentages of various alloys for example 14 carat gold is alloyed with silver and copper green gold with silver and cadmium, and white gold with nickel and zinc Sterling silver has an alloy of copper 7.5 per cent German silver contains no precious metal but is composed of copper zinc and nickel Britannia metal is a mixture of tin with small quantities of antimony and copper Pewter consists of tin 80 per cent, and lead 20 per cent.

A number of cases of nickel dermatitis have been reported within

the last few years from contact with spectacle frames and other articles made of white gold One case of nickel sensitization is of unusual interest a man working at nickel plating developed an eczematous eruption which disappeared in three months after the work was discontinued but reappeared as soon as he began work in a jewelry shop although two years had elapsed since the first appearance of the rash

Cheap jewelry is usually made of plated brass, which is first cleaned in a bath of nitric hydrochloric or sulphuric acid Dipping articles in these solutions is a frequent cause of dermatitis localized on the hands and arms of the workmen. The articles are electroplated with potassium cyanide as the electrolyte and contact with this substance sets up an itching dermatitis with the formation of raised scarlet specks that eventually become confluent. At the site of any break in the skin an obstinate ulceration is apt to develop.

Plated goods are not polished but are subjected to scratch brushing or are lacquered or enameled to prevent tarnishing The application of lacquers containing volatile solvents and other irritants is a frequent cause of dermatitis.

Enameling exposes the worker to skin lesions from intense heat in the process of baking and to the risk of lead poisoning in applying the enamel (Lead enamels generally consist of quartz soda and oxide of lead and are quite different from leadless enamels used for cooking utensils and sanitary ware) Lead fumes are given off when heated articles are immersed in or sprinkled with the enameling material

Ulcerative dermatitis has occurred from the alkalis or acids used in cleaning articles preparatory to enameling Ulcers on the fingers especially in the deep folds of the skin have also been observed among women engaged in dipping articles into enamel cream The ulcers resembled those produced by lime and while the exact cause was not determined in these cases it was believed that tiny particles of the enamel had penetrated the skin through small existing lesions.

Gilding of cheap jewelry is also done by the mercury process, i. e with a fluid amalgam from which cases of mercury poisoning have been reported among the gilders.

Polishing and cleaning the various metals used in the jewelry industry gives rise to numerous cases of dermatitis. Nitric acid mixed with hydrochloric acid is often used for scouring as are benzine, gasoline, trichlorethylene carbon tetrachloride etc. Potassium cyanide has caused dermatitis in engravers, watchmakers, silver polishers, and other metal workers. An eczematous dermatitis on the hands forearms, and face sometimes results from scratch brushing with a revolving brush and the use of sour beer instead of soap and water for cleaning tableware jewelry and other articles of silver or gold Dry polishing with fine crimson rouge may produce dermatitis of the forearms and dorsa of the hands. The substance is said to contain from 0 4 to 2.7 per cent of mercury Precious metals are also polished with hot solutions of caustic soda, and

powdered lime is often applied to keep the metal dry Both of these powerful alkalis are capable of causing burns and erosions of the skin if the hands are not protected by rubber gloves.

Argyria may occur among silversmiths and silver platers in the form of small bluish-black spots on the skin. In one woman engaged in polishing silver a generalized pale blue discoloration of the skin has been observed.

Generalized argyria has also occurred in the past among makers of artificial pearl beads due to blowing silver nitrate on to glass beads through a blow-pipe held to the mouth. This dangerous operation is now carried out by machinery

Cutting up silver leaf has been known to produce argyria among workmen.

In the work of soldering when heat from the lamps is insufficient the use of a blower is often resorted to and some cases of occupational syphilis have occurred among goldsmiths from common use of the blower A compressed air blower should be employed for this purpose, or failing in that an individual mouthpiece should be provided for each worker

Precious Stones.—The chief risk incurred by diamond cutters and polishers of precious stones is that of lead poisoning The rough diamond is usually cut by another diamond and then embedded in a mass of molten solder (known as the "dop") consisting of 60 per cent lead and 40 per cent tin, to which a handle is attached. This contrivance greatly facilitates the process of polishing and is used for other precious stones, with variable proportions of the alloy Polishing is done by pressing the stone against small revolving iron wheels or lead discs covered with diamond powder and olive oil or sometimes with a grinding powder containing lead During this process the stone must be turned in the "dop" from time to time and the worker's hands are constantly in contact with the solder

Scouring of the discs is done by hand with carborundum and emery The work is laborious and raises a considerable amount of stone and metallic dust. Callosities are apt to develop on the right hand from this operation.

For splitting the stones are affixed to a palmwood stick with a composition of shellac, resin and sand or powdered glass which is heated over a glass or spirit flame until it can be kneaded The stone is then pressed into it and cooled in a bowl of water or sometimes the workman cools it in his mouth—a proceeding which accounts for a characteristic wearing down of the incisor teeth in these workmen The stick holding the stone is then fixed into an opening in a block of lead and an indentation made in the stone with a sharp piece of diamond The stone is then split by a sharp blow on a knife placed in the indentation. The diamond chips are picked up from the lead block between the moistened thumb and finger but the risk of poisoning from this procedure is considered

slight. (There is, however, a possibility of dermatitis from the resin and shellac used in fixing the stone to the stick.)

After splitting and polishing the stones are cleaned by boiling in nitric acid in a glass vessel with an asbestos-glass stopper. In case of breakage there is danger from the escaping acid and its fumes.

Artificial Pearls.—Hollow "pearls" are generally made of blown glass coated inside with a nacreous luster which is usually obtained by mechanically injecting into the bead a mixture of gelatin and *essence d'Orient* (made from the scales of the bleak or "ablette"). The bead is then emptied, leaving a thin coating of the luster, and refilled with white wax blown in either by mouth or by machine. For making the beads iridescent hot salts of titanium are applied on the external surface. No ill-effects from these processes have been reported.

Solid "pearls" are made of a milky enamel applied while molten to a copper wire by means of a blow-pipe. The wire is then dissolved by immersion in nitric acid leaving the bead intact. A pearly luster is produced by applying to the outside of the bead an alcohol-ether collodion mixed with *essence d'Orient*. The bead is finished by dipping into an amyl acetate collodion. Some years ago tetrachlorethane was used for this purpose but has been practically abandoned due to the many fatal cases of toxic jaundice to which it gave rise among the workers. Iridescence may also be secured by the use of bismuth oxychloride. A white lead paste is often used for setting the pearls.

The use of amyl acetate and the dipping in nitric acid are capable of setting up a dermatitis if the substances come in contact with the skin, and the white lead constitutes a risk of lead poisoning.

Watches and Clocks.—The work of the watch and clock manufacturer is closely related to that of the jeweler as regards the manipulation of precious metals and jewels, but a far wider range of materials is employed in this industry, including wood, steel, chromium, glass, paint, and numerous other substances. The operations include foundry work such as rolling, cutting out, pressing, and machine hammering of metals, washing, degreasing, and pickling of separate parts, electroplating and chrome plating, lacquering with zapon,[1] enameling, counter tracing, soldering, painting with luminous paint, stone and glass work, and the delicate operations of adjusting, regulating, finishing, and mounting.

Many of the processes expose the workmen to the risk of dermatitis. Dust from the filing or grinding of gold, silver, steel, copper, nickel, and brass, as well as enameling material, although produced in relatively small quantities, may prove irritating. Burns and eruptions are incurred from the materials used in cleaning, degreasing, and pickling the metal parts preparatory to plating with gold, silver, nickel, or chromium, for example, hot alkalis for degreasing, nitrous fumes from pickling, soda, soap, or trichlorethy

[1] Zapon is a solution of colorless celluloid in acetone and amyl acetate.

lene for washing cases and bodies. Even though these operations may be carried out in a closed apparatus, skin injuries occur due to improper manipulation premature opening of the washing compartment and while cleaning the apparatus. In any case a slight escape of trichlorethylene is unavoidable when opening the washing compartment to remove the articles. Cyanide in the baths for gold and silver plating is another source of danger During hot gold plating irritating fumes of cyanogen and hydrocyanic acid are given off which may cause both cutaneous and systemic injury unless carried off by an effective exhaust. Exposure to intense heat in many of the operations such as enameling soldering etc. causes heat rashes.

Dermatitis and indolent ulcers are produced in the process of chrome plating which is increasingly used in the manufacture of time-pieces. (See Electroplating.)

Enameling may cause lead poisoning as described above, although enamel is now being largely replaced by lacquer which presents a hazard from resins solvents, etc. Zapon in modern factories is sprayed on in front of an exhaust. Nevertheless numerous cases of dermatitis from lacquer have been reported in this industry

Dermatitis of the fingers may result from handling the flux used in soldering stainless steel watch cases. The flux consists of fluorides and borax and is coated over the case in order to clean and etch the metal and also protect the parts not to be welded from the flame of the blow torch The blow torch flame applied to the flux liberates hydrofluoric acid which may cause nasal ulceration and conjunctivitis.

The application of luminous paint to the dials of watches and clocks has caused irritation and eczematous lesions among workers with sensitive skins, but its greatest danger has been the ingestion of radioactive substances. This has produced necrosis of the jaw bone grave anemia and in many cases death A number of cases have been reported among women engaged in painting dials with luminous paint containing radium and mesothorium The disease has resulted from the habit of pointing the paint brushes with the lips.

Dermatitis may arise in this industry as among cabinet makers from contact with woods such as satinwood mahogany ebony walnut etc

Wounds of the fingers due to work at the furnaces or at the milling and filing tools and presses are fairly numerous and these are subject to secondary infections

An occupational stigma of watchmakers and repairers is a short right thumb nail which is very hard and much thicker than the other finger nails. It is due to the frequent opening of watch cases

JUNK DEALERS AND WRECKERS

While the junk business is mainly concerned with the collection and resale of old metal it has many ramifications and the work of

the larger concerns is closely allied to that of wrecking contractors in that they remove safes motors machinery etc from buildings that are being demolished

Besides metal many dealers collect old clothing rags, worn-out mattresses and furniture newspapers bottles, etc. In some cases a certain amount of renovation is done but generally the work of the junk yard is destructive i e clothing is made into rags hair removed from mattresses and upholstery metal articles are reduced to scrap

Those who deal with rags and bedding are exposed to a wide range of infectious diseases and also to infestation by lice and bed bugs. (See Pulp Paper and Paper Products.) Hayhurst has reported several cases of tetanus in some large plants. Handling metal appears to be less dangerous but the work of the junkman is necessarily a dusty and dirty one and any wound or abrasion is likely to become infected

Long sections of pipe and large metal articles are cut into scrap by a cutting machine or an oxyacetylene blow-pipe. This last operation exposes the worker to burns from the flame and the molten metal Cutting lead brass, bronze, zinc, or articles containing these metals liberates metallic fumes that may cause dermatitis and systemic poisoning There is a special danger of lead poisoning in the cutting of old iron or other metal which has previously been painted with minium or lead colors. Impurities in the acetylene such as sulphuretted phosphoretted, or arseniuretted hydrogen constitute a further hazard

Injuries may occur from explosions which take place while cutting containers that have held such liquids as benzene or sulphuric acid

Similar risks are incurred by workmen who use the acetylene blow pipe for wrecking buildings or dismantling ships especially if the work is done in an enclosed place. Numerous cases of lead poisoning and brass fever have resulted from this operation

Wreckers are exposed to dust containing cutaneous irritants of various sorts lime from plaster cement, and concrete falling on perspiring skin lead from painted surfaces tar and creosote from roofing materials insect poisons that may have accumulated in crevices, etc In the dust of old buildings pathogenic organisms may also be encountered

LAUNDRY WORKERS AND WASHERWOMEN

Establishments for washing clothes range all the way from genuine hand laundries in which women work at open tubs and do the washing starching and ironing by hand to the highly mechanized plants whose workers do little more than tend machinery Between these extremes are many laundries that do the work partly by hand and partly by machine. Many of the so-called hand laundries send the clothes to a steam laundry to be washed starched and mangled, while they merely finish the starched pieces with a hand iron. In

the large steam laundries some of the finer operations are still done by hand. Despite the multiplicity of commercial laundries now in existence there is still a great deal of washing and ironing carried on in homes as a domestic activity and in many communities the washerwoman takes the clothes to her home and washes and irons them under primitive conditions.

In the latter case a reversal of rôles may take place and the employer receive injury from the worker for instance, many clean homes become infested with vermin whose progenitors were brought in with the "wash."

FIG. 131 —Chronic dermatitis due to constant use of liquid soap

Women who wash by hand frequently develop callosities on the inner surface of the forearms from rubbing against the edge of the tub and also suffer from dermatitis due to constant immersion in hot soapy water bleaching powder and other irritating substances. The nails frequently become loosened and a crescent-shaped detachment occurs, but without complete loss of the nail. The macerated condition of the skin paves the way for pathogenic bacteria and fungi and monilial paronychia is a common occupational affection of washerwomen J C White reports a similar paronychia among a group of houseworkers using ordinary soap with prompt disappearance after the substitution of soap containing no animal fats According to Gardiner however cottonseed and coconut oil soaps are more irritating than palm and tallow soap since the former require a higher equivalent of alkali for saponification and when this is liberated the action on the skin is more injurious It is believed that a greater alkali content rather than the source of the fat is the important factor

The rash is usually erythematous and vesicular Prolonged

exposure causes thickening and cracking of the epidermis and the formation of thin adherent scales In persons with weak circulation heat causes the blood-vessels to dilate and undergo passive congestion and consequently the hands have a dark red or livid appearance When the hands are cold there are shooting pains, and when warm they itch There is a distinct loss of sensation in the fingers In the more advanced cases the skin becomes greatly thickened fissured and ulcerated The fingertips are enlarged and the nails become black thick friable and raised from the bed

In hot moist workrooms particles of lye suspended in the steam cause drying of the upper respiratory passages and irritation of the mucous membranes. Mycosis of the external auditory canal has also been observed in these humid rooms due to the *Aspergillus nigricans* or *flavescens* which causes an irritation of the tympanic membrane as well as the walls of the canal and in some cases impairs the hearing

Hand ironers are subject to synovitis of the long extensor tendons of the right forearm beginning at the proximal end of the metacarpal of the thumb and extending half way up the forearm In some cases the shoulder joint is affected Pressure of the fingertips on the iron and the practice of applying starch with the fingers gives rise to paresthesia of the fingers with dulness or peculiar itching and tingling sensations of the tips. These symptoms are severe at night and usually pass off during work. There is marked atrophy of the web between the thumb and index finger

The routine procedure in laundries is roughly as follows The bundles of soiled linen are opened and each piece is marked with ink. The flat pieces are then separated from the garments. The clothes are steeped in water for a time and then washed with hot water soap and washing and bleaching powder They are rinsed and wrung out by hand or placed in a hydro-extractor After the excess of water is removed the clothes are starched and dried in drying chambers by steam heat or hot air applied by fans. When dried the linen is fed into calender machines (mangles) consisting of large steam or gas-heated cylinders having one or more rollers. These machines also fold the flat pieces The starched pieces are finished by hand or by machine Many different types of washing starching mangling and ironing machines are in use including those designed especially for ironing collars and cuffs, and some which are capable of ironing the largest and most complicated pieces of wearing apparel

A number of years ago the Medical Officer of Stockport England mentioned the danger of using an ink containing aniline oil for marking the linen The English Medical Inspector of Factories, in his report for 1924 described two cases of poisoning which consisted of headache vertigo and cyanosis due to skin absorption of an ink solvent containing aniline which the workers used for one hour to remove ink stains from a tablecloth

Burns are frequent during ironing whether by hand or by machine

and traumatic injuries occur among workers who tend the calender machines, the fingers being caught while feeding the material into the rollers.

The temperature in the mangle and ironing department is generally very high between 80° and 100° F and clouds of steam arise as each dampened article comes under the heated iron. The workers are subject to miliaria, intertrigo etc., due to the combined heat and humidity. Hydrocystomata, which consists of superficial vesicles filled with clear fluid is not infrequently observed on the faces of laundrywomen.

The constant standing necessary in this industry favors the development of varicose veins and ulcers of the leg, and tends to weaken the arches of the feet.

Occasional infections have been reported among laundry workers which were not due to the specific character of the work, but resulted from minor accidents. For example, tetanus occurred in a girl who ran a splinter into her finger while cleaning the floor of a laundry lunch room. In a second case, a man received an injury while starting the machinery and tetanus developed in the wound.

The hygienic conditions in laundries are highly variable. In some, forced ventilation is used and the vapor is carried away by exhaust ventilation and revolving fans, while in others no attempt is made to modify the humid heat.

It is desirable to have concrete floors that slope towards a drain and slatted wooden platforms for the workers to stand on. Rubber aprons and watertight boots should be provided for those who do the wet work. Mechanical ventilation should be installed to provide fresh air and remove the steam especially in the rooms where drying and wringing by hydro-extractors is done. Tubs should be equipped with hoods to draw off the steam and dried air at a lower temperature should be brought into the room to replace the steam. Or currents of hot, dry air may be passed over the tubs to dissipate the steam as it is being formed.

Soiled linen should be boiled or otherwise disinfected before sorting is done, especially when it comes from houses or hospitals in which there are patients with contagious diseases.

To prevent washerwomen's dermatitis machine washing should replace hand work as far as possible, and the skin should be protected from contact with alkaline soaps and bleaching powders.

LITHOGRAPHERS

(See Photographing Lithographing, etc.) These workers may develop dermatitis from the various chemicals used in photography such as the developer's metal, hydroquinone etc. Ammonium bichromate used to sensitize the metal plates is the chief cause of dermatitis in this industry. Occasional cases of dermatitis and burns may occur from the acids used for etching the metal plates.

LUMBER AND WOODWORKING INDUSTRIES

Workers in contact with wood from felling trees in lumber camps to sawing planting building construction the manufacture of wooden articles, and fine cabinet making may incur dermatitis from the irritants present in certain woods.

As a rule the moist sawdust or freshly cut surfaces of the tree are the most dangerous, although in some cases the bark or the resin alone proves irritating The wood of a few trees causes dermatitis even when thoroughly dried and seasoned Furniture made of rungus wood for example has produced severe dermatitis although old and worn Numerous cases of dermatitis are reported among cabinet makers who work with satinwood and other exotic ornamental woods.

Some workmen exhibit sensitivity at the first contact others become sensitized after varying periods and are unable to return to that particular job thereafter still others, sensitive at first gradually become immune. The incidence of dermatitis from wood is highly variable in some factories only 2 or 3 per cent react, while in others over one-half are affected (See chapter on Plants and Woods for a more detailed consideration of this subject.)

Lumberjacks are exposed to this risk, especially in tropical countries where the number of irritating trees is greatest. They are also subject to traumatic injuries and to the skin hazards common to outdoor workers. In some places trees are still felled by means of the bill-hook, hatchet and hand saw topping off branches and other operations are done by hand although portable machines are available to do the work more quickly and economically In any case traumatic injuries from axes, hatchets, adzes, cross-cut saws, cutting machines, flying fragments of wood falling timbers, rolling logs, etc. are very frequent. While trimming the trees and removing the bark during cold weather the axe is likely to glance off the frozen wood and cause cuts of the knee or calf Steel cables used in the flotation of logs on rivers are likely to become worn and cause abrasions of the palms. Pyogenic infections have been observed from this cause.

Besides felling trees topping, barking cutting into lengths, and transporting the logs, work in a lumber camp includes clearing away underbrush and in some cases tilling the ground and planting young trees for reforestation This phase of the work exposes the employees to many of the skin diseases described among agricultural workers. Frost-bite of the ears, nose, cheeks, fingers, and feet are common among workmen in northern lumber camps.

Housing conditions are often unsanitary and favor the spread of infections and various forms of itch "Lumbermen's itch whose etiology is somewhat obscure, is believed to be scabies.

In lumber mills and woodworking factories machine tools of many types are used for cutting sawing planing splitting slicing scooping drilling mortising carving molding making grooves, discs

casks wheels, spokes, handles for implements, shoe lasts and various other wooden articles in common use. The machines are equipped with exceptionally sharp cutting blades and run at a high speed. Finishing is done on sandpapering machines of several different types. For large production, drum machines are used which consist of three drums each covered with sandpaper of increasing fineness and equipped with a brush to clear off the dust.

Great masses of chips and dust produced by most of the machine tools are removed by suction apparatus. Nevertheless, a quantity of fine dust inevitably falls on the workmen, especially in the process of sandpapering, and it is in these woodworking establishments that the incidence of dermatitis from woods is greatest.

The authors found 11 cases among 100 workmen in a cabinet making plant due to contact with Brazilian walnut. Most of the patients were employed at dusty jobs

Wood that is to be exposed to the weather must be protected in some way to make it more resistant, and this is done by several different methods. Those in common use are impregnation with creosote, zinc chloride, mercuric chloride, chlorophenols and diphenylchlorarsine. "Kyanization consists of steeping the dry wood in a solution of mercury bichloride and sodium fluoride. This solution is now being replaced by a mixture of sodium fluoride and organic compounds, generally dinitrophenylaniline which is commonly known as 'basilite. Copper bichromate brushed or sprayed on is another effective preservative and is applicable to either soft or hard wood

Shingles railroad ties (sleepers) and telegraph poles are usually impregnated with hot tar oil or creosote oil which is driven into the wood under great pressure in large airtight cylinders from which the air is removed by a jet of steam In some cases, this is followed by a bath of the same oil at normal temperature, and finally by a bath of zinc chloride.

In the process of creosoting wood the workers may be splashed and their clothing soaked with the solution which gives rise to lesions similar to those caused by tar These consist of acne, eczema ulceration and in some cases warty growths that may undergo malignant degeneration.

Mackenzie described a carcinoma on the back of the hand of a workman who had been engaged for thirty years in creosoting railroad ties. Associated lesions consisted of black plugs in the follicles of the hands and forearms some resembled warts and one appeared on the scrotum. Some of the growths were as large as nuts and were covered with a hard crust that revealed a red bleeding surface on removal Other similar cases have been observed following contact with creosote and tar (*q v*)

Mercury poisoning has been reported due to the use of the bichloride solution for impregnating timber Fumes from zinc chloride formed by pouring hydrochloric acid over zinc slag in a tank have

caused irritation of the skin and mucous membranes in a number of cases. (See Zinc.)

Carpenters develop dermatitis from irritating woods and liquids used for cleaning polishing staining and varnishing. Cases of lead poisoning have been noted among carpenters who use lead colors or coating with a base of lead protoxide in oil of turpentine and spirit.

Bursitis of the wrist elbow and knee are frequent among carpenters who lay or scrape parquet flooring. Tenosynovitis of the thumb is often developed from the rotary movement of the wrist and forearm in operating the hand plane. Callosities arise on the thumb and index finger from friction with the plane and on the palm from the use of the chisel.

Temporary machine shops are often located on the sites of large construction jobs and wounds of the hands fingers, and forearms from drilling and planing machines and saws are very common among the carpenters. Secondary infections frequently follow.

Fillers forced into the pores and cracks of wood to make a smooth surface before polishing are composed partly of turpentine which is an irritant. Fillers made of a paste of bichromate and plaster of Paris have produced severe dermatitis.

For staining inferior woods to imitate walnut potassium bichromate is used with sodium carbonate. The bichromates also darken and enrich the color of mahogany oak, walnut and beech.

Aniline colors such as Bismarck brown and Vandyck brown used for staining wood and ammonia solution for fuming or darkening oak cause irritation when used in strong concentrations.

Suppurative skin lesions have been reported from carving the wooden handles of walking sticks previously treated with a solution of iron acetate. Dermatitis from contact with cocobolo wood has occurred in a walking stick factory and Abramowitz and Swartz report a case from carving a handle for a knitting bag.

In the manufacture of furniture both carpenters and cabinet makers share the same risks from dust and chemicals used for polishing staining varnishing and shellacking. Cabinet makers are more subject to irritation from the dusts of the fine woods such as satinwood rosewood and mahogany which arise in the process of sandpapering and polishing.

Furniture polisher's eczema is seen on the fingers which become raw and tender from contact with pyridine in denatured alcohol or with other irritants.

Carpenters and cabinet makers are exposed to skin affections from contact with glue, especially in the application of veneers. Three cases of dermatitis with purulent eruptions were reported from a German furniture factory in 1920 which were caused by the use of glue containing lime and ulcerous lesions were reported from Switzerland from contact with glue.

Diphenylchlorarsine and the chlorophenols are also used as wood preservatives and cause dermatitis.

Arsenic and antimony compounds, also used in the preservation of timber are additional sources of dermatitis.

To remove paint and grease or lighten the stain on wood strong solutions of soda are used Amyl acetate ("banana oil) is also a common paint and varnish remover It often contains benzine methyl alcohol carbon disulphide white spirit, or carbon tetrachloride. These may be used separately or in combination in the process of "*stripping off*" *i e* cleaning off paint, dirt, or grease

Oxalic acid is used to bleach such woods as mahogany and walnut and may produce inflammation around the nails and soreness of the fingertips.

Some Indian varnishes especially in lhet, give off irritating vapors that *produce inflammatory swellings, itching and pustules affecting* the whole skin but disappear after a few hours.

Dermatitis from the use of cellulose varnishes is not infrequent among workers in furniture factories. Some of the cases seen however are due to the use of solvents such as benzene to clean the skin. *The lesions begin with erythema and develop into a definite* eczema

In the making of moldings and picture frames, dermatitis from dust occurs and wood alcohol and amyl acetate used in the process of bronzing and gilding are irritants.

In factories that manufacture rules coated with lead chromate many cases of lead poisoning have been reported Maracaibo box wood and African boxwood of which rules are often made are among the irritating woods that cause dermatitis.

MACHINERY MANUFACTURE

The production of machines, mechanical apparatus implements instruments etc is one of the most important of present-day industries, especially in the United States where technological operations have been carried to *an exceptionally high point of speed and* precision. The articles manufactured for use in homes offices stores, factories, and farms are too numerous to list.

Raw *materials* for the manufacture of such articles include iron, steel, cast iron crude or molded steel, copper zinc lead, aluminum brass, bronze various alloys, *etc supplemented by mineral* vegetable, and animal products such as flint stone wood cardboard paper leather animal hair rubber vulcanized fiber also coloring and varnishing materials such as red lead iron oxides oil colors varnishes, enamels, etc

The preliminary processes include molding forging rolling stamping punching wire drawing plate bending cutting and similar rough shaping operations which are usually done in a separate plant.

Forges and rolling mills receive as raw material puddled iron and steel in blocks, bars ingots blooms and billets which are shaped by forging with shingling hammers and by pressing or rolling

(See chapter on Iron and Steel) Old iron and steel are melted in furnaces and reshaped

In these plants such articles as links, rods, levers, collars, bolts, nuts, spindles, horseshoes, shackles, hooks, wheels tubes, cylinders guns, shells, and armor plate are made. Forging and welding may be done by a blacksmith who uses a hand hammer and anvil while an assistant holds the material with a pair of pincers and delivers alternate blows or by a group of smiths who strike in turn or power driven machinery may be used in hand forging to deliver the blows. Machine forging employs automatic power-driven machines and special tools or dies designed to produce the work desired It is done by steam or pneumatic hammers, drop hammers, horizontal die-forging machines, or hydraulic presses. The results are much more accurate than can be attained by hand forging

Workmen at the forges and rolling mills develop eruptions which result from excessive heat combined with perspiration and coal and metal dusts. Pustules furuncles, and abscesses occur on the arms, axillæ, and umbilicus intertrigo in the fold areas and miliaria all over the body

Burns occur on all parts of the body but particularly on the dorsum of the hand and here small white scars are characteristic of iron workers. Other stigmata are callosities on the palmar surface of the fourth and fifth fingers caused by handling the hammer and hygromata of the elbow

Blepharitis results from the effect of radiant heat and deposits of small particles of coal or metal on the edges of the lids. Cicatrices, small ciliary gland cysts, conjunctivitis, and burns of the cornea from flying sparks are often observed Bits of metal sometimes become embedded in the cornea and leave a blackish stain of iron oxide.

Dust mixed with wax is likely to cause occlusion of the external auditory meatus, and not infrequently terminates in furunculosis.

Prolonged standing favors the development of varicose veins and ulcers.

For the construction of more intricate machinery forged or molded articles are brought to the factory where they are finished smoothed sized and shaped for accurate fitting by means of lathes, boring drilling milling threading screw-cutting and grooving machines. During this phase the materials are sometimes tempered with water oil molten lead cyanides, etc and this process is followed by annealing Dermatitis may be caused by the oil or cyanogen compounds

Machine tools include both wood working and metal-working machines Metal must be held with powerful clamps, vises, chucks, and fixtures while wood can be presented to the cutters directly by hand against guides, or with feeding rollers. Milling machines equipped with cutters are used for finishing flat surfaces and for producing every possible shape required in metal construction. Flats, bevels, curves, and slots can be milled along a casting or

forging with perfect accuracy and exactly similar pieces turned out by the hundreds or thousands. Wood is milled on a machine of somewhat different type but with the same precise results. The process gives rise to much dust and pigmentation and tattooing of

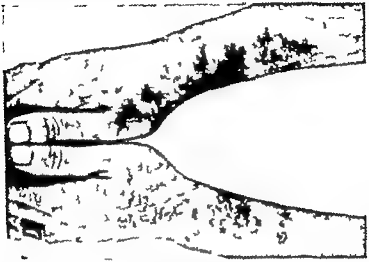


Fig. 132.—Oil folliculitis in a lathe machine operator. (Case of Drs. Foerster and Wieder.)

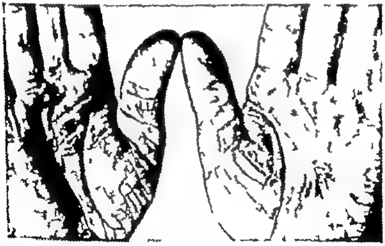


Fig. 133.—Dermatitis from grease and oil in a machinist. (Case of Drs. Foerster and Wieder.)

the hands are seen among milling machine operators due to penetration of the skin by small particles of metal.

Lubrication by oil, soapy water or an emulsion enables the tools to work at a higher speed. Contact with the insoluble cutting oils

causes dermatitis, particularly oil acne. Work clothes soiled with grease and oil produce similar lesions.

Finishing comprises scouring grinding polishing sharpening etc. which are the sources of quantities of dust. Scouring may be done in an acid bath although the sand spray is most frequently used The spray is projected at great speed by air steam or water under pressure which carries with it sand carborundum lead shot or other abrasive material The spray is applied under a hood in a special apparatus or chamber or is completely enclosed Nevertheless, the workers are exposed to a certain amount of dust containing silica calcium carbonate, and impurities such as iron iron oxide, and lead Sand containing as little as 0.05 per cent of lead has been known to cause lead poisoning among the operators. The use of masks is a necessary safeguard in this operation

Acids used for cleansing scouring and pickling metals give off fumes which sometimes cause acute poisoning Nitric acid either by its fumes or splashes from the vats, may cause dermatitis, burns or inflammation and ulceration of the mucous membranes of the mouth nostrils and conjunctivae and also necrosis of the teeth

Grinding machines with high-speed wheels of emery corundum carborundum and other abrasives are used to shape the metal parts. They reduce the size of castings for stoves doors, dampers, etc of forgings for cars and engines and numerous other items for agricultural and domestic use which can be cast or forged to nearly the proper dimensions and then quickly and economically finished by grinding Grinding machines are also used for finishing sharpening, and polishing

Polishing is done either by grindstones or by a series of files of increasing fineness or by brushing wheels of leather basil or felt lined with such abrasives as brick dust, pumice, Tripoli yellow ochre, Viennese chalk rouge (oxide of iron) putty powder etc. A large amount of dust containing sand abrasives, metal leather and cloth is raised in this process which irritates the skin as well as the mucous membranes. Even when these processes are done wet or with oil the dust is abundant. Polishing pastes and the solvents used for final scouring such as methyl alcohol benzene, benzine, and turpentine may cause dermatitis, ulceration and fissures of the skin Brushing with a paste of slaked lime to remove all fatty matter is a frequent source of ulceration of the fingers and hands. Cyanogen compounds, hydrochloric acid and oxalic acid used in cleaning and polishing also produce dermatitis.

Galvanizing plating with zinc, lead chrome or nickel scraping, polishing pumicing painting and varnishing are also included in the process known as finishing

The plating of metals provokes many cases of dermatitis. (See Electroplating) Nickel platers develop an inflammation of the skin which later becomes vesicular This is attributed either to the strong cleansing solutions or to the nickel sulphate potassium

cyanide or zinc chloride in the electrolytic baths. Dermatitis has been noted from the vapors given off by the electrolytic bath in the *manufacture* of percussion caps and cartridges. Five cases in a year were reported in New York State from electroplating typewriter parts.

Ulceration of the hand has been reported among workers from electroplating with copper. Articles are generally coated with copper previous to nickel-plating.

Chrome-plating may cause dermatitis and ulcers of the nasal mucous membrane. (See chapter on Chromic Acid and the Chromates.)

Zinc-plating may produce a purulent inflammation of the hands due to contact with the zinc sulphate. (See chapter on Zinc.) In galvanizing wire and other articles, the material is first passed through dilute sulphuric acid, next through a weak solution of hydrochloric acid, a flux of zinc chloride and ammonium chloride, and finally through molten zinc. Each of these processes presents a skin hazard.

Paints, solvents such as benzene or rapid drying paints, and lacquers used for finishing are all potential skin irritants in this industry.

The final step in the manufacture of machinery is assembling and fitting the different parts by such operations as tightening, cold and hot riveting by hand or by the pneumatic hammer, smoothing, white soldering, autogenous welding, hard soldering, etc.

Lesions of the skin and the mucous membranes of the nose, mouth and upper respiratory passages occur from the fumes of hydrochloric acid, zinc chloride, etc., liberated in many operations, but especially in soldering and welding.

The melting of beryl, a light metal used in alloys with other light metals such as aluminum, causes the evolution of hydrofluoric acid fumes which can cause constitutional symptoms and cutaneous eruptions lasting several days. (See Fluorides in chapter on Insecticides.)

Radiant heat to which the workers are exposed in numerous processes produces pigmentation and erythema of the exposed parts.

File cutters are subject to blisters and characteristic callosities of the hands which, if neglected, develop into painful scars and may even suppurate. Small traumatic lesions may become infected and ulcerated.

Certain woods that enter into the construction of some machines, instruments, tools, cutlery, etc., are capable of producing dermatitis, for example, cocobolo wood, which is extensively used to make handles for tableware, tools, and parts of scientific instruments. (See chapter on Plants and Woods.)

Acute and chronic tenosynovitis of the thumb and radial muscles are observed among many workers whose occupation calls for excessive repetition of the same motions.

THE MATCH AND MATCH BOX INDUSTRY

Besides phosphorus, numerous other substances enter into the manufacture of matches and match boxes and many are capable of causing dermatitis. A brief résumé of the materials and processes of manufacture will indicate the sources of danger

In the United States white or yellow pine is generally used for making the splints, while in Europe aspen is preferred Since the wood is well seasoned before coming to the factory it is doubtful whether there is any risk from this source. For treatment of the splints and the composition of paste for the match heads, the following materials are generally employed

Phosphorus sesquisulphide (P_4S_3) used in the paste for strike anywhere matches. When mixed with potassium chlorate the substance is highly explosive. P_4S_3 is a skin irritant to sensitive individuals. Frei found in a series of experiments, that 1.5 per cent of it on the surface of safety-match boxes caused positive reactions in 3 among a group of 140 persons who were patch-tested with the substance for twenty four hours.

Potassium chlorate ($KClO_3$) used for the purpose of ignition.

Manganese dioxide a catalyzer for potassium chlorate.

Zinc oxide or zinc white used in the paste as a filler

Glass powder consisting mainly of silica, acts as a filler and increases friction.

Asbestos powder in this industry a mixture of the silicates of magnesium and aluminum supplements the action of the ground glass

Plaster of Paris also a filler

Glue combines the ingredients and fixes them to the match sticks and to the sides of the boxes for friction strips.

Gum arabic sometimes used as a substitute for glue.

Sulphur the combustible element in safety matches.

Iron oxide a filler and coloring agent for safety matches.

Infusorial earth consisting of almost pure silica used as a filler

Potassium bichromate for thickening and waterproofing glue and gum

Amorphous (red) phosphorus used in the friction strips on boxes and folders of safety matches.

Antimony sulphide (Sb_2S_3) a modifier of the reaction between chlorate of potash and amorphous phosphorus in the friction composition for safety matches.

Paraffin wax for coating the splints before the paste is applied to the tips.

Ammonium phosphate for impregnation of the splints to prevent after-glow when the match is extinguished.

Stearine obtained by treating tallow with potassium hydroxide and subsequent neutralization with dilute acid is used with a cotton wick for the stems of waxed vestas.

Gum dammar or copal, for hardening the stearine in wax matches and also used in the striking compound for safety matches.

Aniline dyes (fuchsin) for coloring the matches and boxes.

Although several of these substances are capable of causing injuries of the skin, comparatively few cases are reported from match factories at the present time since practically every operation is carried out by machinery. In factories that use separate machines for the different processes the workers may incur some risk while carrying the materials from one machine to another. However, it is estimated that 90 per cent of the matches made in America, Great Britain, Sweden, and some of the other match-producing countries are now manufactured by great continuous automatic machines. In these, blocks of wood entering at one end are subjected to all the operations of splitting, impregnation, dipping, drying and boxing without being handled except for inspection and regulation of the number of matches in each box at the end of the whole process.

Blocks of thin veneers of wood are cut automatically into match-sized splints which are then impregnated to prevent after-glow by boiling in ammonium phosphate to which coloring matter is often added. Following this the splints are dried and polished in a revolving drum. Next they pass through screens that collect and lay them all in the same direction so that they can be fixed upright in a slowly moving perforated metal band. On this band they are carried to a bath of paraffine wax into which the heads are dipped and then to the igniting composition consisting essentially of potassium chlorate, phosphorus sesquisulphide, and potassium bichromate, which forms the bulb or match head. A smaller tip of somewhat more inflammable material containing a greater proportion of P_4S_3 is placed on the bulb by the next process. During the remainder of their journey on the continuous band the matches undergo further drying. When they arrive at the end of the route they pass through an ejecting mechanism and are run into a vibrating trough from which they are dropped into boxes by means of a mechanical cut-off. At this stage, girls are employed to see that the boxes are not defective or overfilled. Safety match heads contain only potassium chlorate, glue, and starch, but the striking surface of the box contains red phosphorus and sometimes a small percentage of P_4S_3.

Even under these favorable conditions certain skin hazards exist. The trough containing the combustible paste must be replenished from time to time, and in doing this the hands and clothing of the workmen may become contaminated with the mixture. Also, the girls who examine and adjust the boxes after they are filled incur a risk from the paste which is still moist and soft.

Match boxes of wood and cardboard and cardboard folders are also made by machines. The friction strips are applied after the boxes are filled.

In packaging the filled boxes, also done automatically, the girls who keep the boxes in line for the packaging machine touch the sides of the boxes and run the risk of dermatitis from the ingredients in the friction strips and the dyes on the boxes. For ordinary matches the striking compound consists of glue and sand, and is less dangerous than that for safety matches which is made of red phosphorus, glue and resins.

In the absence of up-to-date factory methods, the cutaneous hazards in this industry are numerous. When the workrooms are not adequately ventilated there is always a certain amount of phosphorus in the air. In one survey 1.7 gm. of phosphorus has been found on the hands of a worker after four hours of labor in a London factory.

In store rooms also, where the raw materials are kept in open boxes or barrels, there is likely to be a considerable amount of dust in the air. Gloves and respirators should be worn by the workmen who handle these substances which, for greater safety, should be kept in dustproof boxes and taken out from the bottom by means of a hopper. The room should be well ventilated and swept wet after each shift. Shower baths should be provided and bathing made compulsory; the work clothes should be washed at frequent intervals.

Unless the glue is cooked in a well-ventilated room, the workers are exposed to injurious dust and fumes. The work should be carried out under ventilating hoods.

The most dangerous jobs are the preparation of the paste, dipping and drying, and filling the boxes with matches. Burns of the hands occur among workers who release the matches from the frames preparatory to boxing. These are very painful if the paste contains chlorate, but heal more readily than those from paste containing red lead which is sometimes used. Chromium compounds are another source of danger. During the war of 1914–1918 some Danish and Swedish matches contained from 3 to 8 per cent of chromium salts. These caused ulceration of the fingers and mucous membranes among 84 workers.

Contact with potassium hydroxide in this industry may also cause severe burns of the skin and mucous membranes resulting in persistent deep ulcers and loss of the nails.

Cases of dermatitis under the pocket areas of the fingers and hands, and of the face, have been reported among workers due to contact with the striking surfaces of safety match boxes. They have been attributed to the phosphorus sesquisulphide (P_4S_3) which in some factories is added to the red phosphorus on the striking surface of the safety match box. A case was reported in which the dermatitis was due to the P_4S_3 which was deposited on the striking surface of the box of strike-anywhere matches by the action of striking the matches on the ordinary sand and glue mixture which constitutes the striking surface of such boxes.

MEDICAL AND ALLIED PROFESSIONS

Physicians, Surgeons Dentists, Veterinarians, Nurses, Orderlies, Laboratory Workers, Druggists Chemists and Technicians

By the very nature of their work members of the medical profession are subject to infectious and contagious diseases from contact with the sick and also to dermatitis from materials handled or otherwise encountered in the course of treatment and disinfection

Surgeons, gynecologists bacteriologists and workers in the dissecting and autopsy rooms are exposed to such diseases as syphilis glanders tularemia tuberculosis verrucosa cutis, spirochetosis icterohemorrhagica psittacosis typhus, typhoid and relapsing fevers trachoma, etc. A case is reported of accidental contraction of blastomycosis from an autopsy of a diseased patient.

The incidence of skin disease in the medical professions is high despite the use of rubber gloves and other protective measures. Pricks from the hypodermic needles and trauma from surgical instruments lead to pyogenic infections. Many skin diseases occur from direct contact with infected persons or objects. Mycotic infections impetigo contagiosa, and pediculosis are occupational risks for doctors midwives nurses, hospital attendants, and social workers.

Extragenital syphilis may be contracted by physicians, midwives and nurses from diseased patients and by physicians and attendants in the dissecting and autopsy rooms. The lesions occur chiefly on the hands and fingers ulcers of the eye often result from rubbing with contaminated fingers. The authors have seen a chancre of the eye in a laryngologist from a splash of syphilitic blood during an operation.

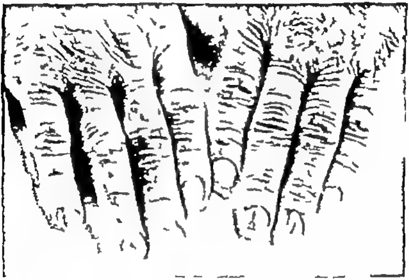
Tuberculosis verrucosa cutis or verruca necrogenica may be contracted from the human or animal cadaver and occasionally from other external sources by pathologists, veterinary surgeons, bacteriologists nurses dissecting room and autopsy attendants, and undertakers. It has been demonstrated however that the incidence of tuberculosis in any form is not greater in these occupations than in the general population. Dermatitis among physicians and surgeons due to sensitivity to disinfectants is fairly common. Some of the most common irritants are mercuric chloride and hexylresorcinol and those mentioned below

Physicians.—Erysipelas occasionally occurs and erysipeloid has been reported in a physician from a prick of the finger while making chondrosulphuric acid from a pig's snout

Radiodermatitis is a risk in the examination and treatment of patients by roentgen-ray or other radioactive substances. (See Physical and Mechanical Agents.)

Cutaneous eruptions occur among sensitive individuals by contact with hydrogen peroxide and iodine and in one case from picking up a piece of gauze saturated with iodoform

Dermatitis from novocaine and pantocaine is not uncommon among oculists, in one case leading to a painful and disabling thickening of the nails from novocaine and in others to dermatitis of the fingertips resulting from pantocaine



F 131 Radiodermatitis (occupational) in physician. (Collection f Dr Howard Fox)

Dermatitis has occurred among pathologists from contact with formalin, which may also cause onychia after prolonged contact with the nails.

A vesicular dermatitis from rubber gloves was observed in a doctor In this case patch tests revealed no reaction to the accelerators, but there was a positive reaction to a compound formed during the process of vulcanization by the cold cure with sulphur monochloride Several cases of dermatitis due to rubber gloves among surgeons have been seen by the authors.

Dermatitis is frequently reported among doctors who handle plaster of Paris in splints, casts, etc.

Dentists and Dental Aides.—Syphilis may be transmitted during the course of dental work when open lesions are present in the patient's mouth The authors have observed chancres of the fingertips from this source. Tuberculosis of the skin is sometimes contracted from patients Radiodermatitis may result from the incautious use of roentgen-rays.

The most frequently reported occupational lesion among dentists, however is dermatitis from contact with cocaine, novocaine, and

procaine hydrochloride. Contact often occurs by leakage from the syringe onto the fingers.

Dermatitis has occurred among dentists from contact with mercury in amalgam fillings. A case of contact dermatitis is also reported in a dental nurse from handling such fillings containing small droplets of mercury

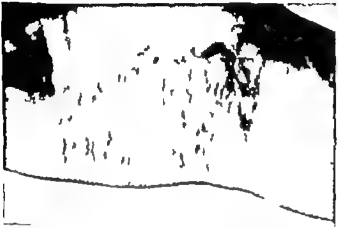


FIG. 116.—Occupational dermatitis in an anatomist due to formalin. (Case of Dr F P Lowenfish Vanderbilt Clinic Columbia University New York.)

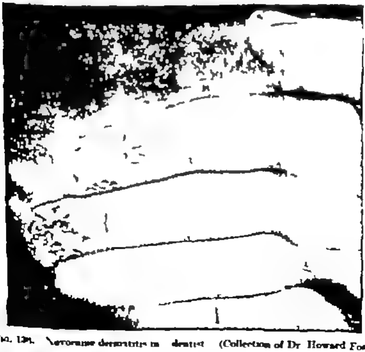


FIG. 120. Novocaine dermatitis in a dentist (Collection of Dr Howard Fox.)

Dental technicians have been reported to have developed dermatitis from molding methyl methacrylate resins. The monomer a colorless liquid used to soften the polymer was the actual cause

Formaldehyde phenol cresol thymol wood alcohol ethyl silicate apothesine butyn epinephrine and sterilizing solutions of borax have also produced lesions of the skin among dental workers. Two cases have been reported from contact with eugenol carnation oil and *oleum caryophyllorum*

Handling plaster of Paris while making casts has caused onychorrhexis in a dentist.

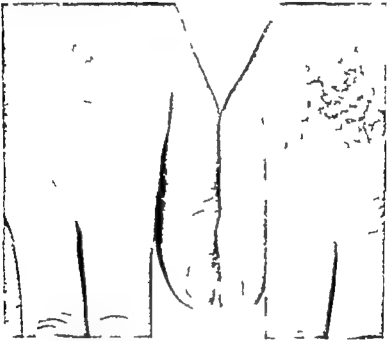


Fig 137 —Occupational dermatitis in a nurse due to potassium mercuric iodide. Positive patch test. Successful desensitization (Case of Dr R M Kesten, Vanderbilt Clinic Columbia University New York.)

Veterinarians.—Veterinary surgeons and doctors are likely to contract such animal diseases as are transmissible to man For example a case has been reported of erysipeloid due to the prick of a needle contaminated with swine erysipelas. Sarcoptic mange has followed dissection of the carcass of a diseased horse, and may also be contracted from sick animals.

Anthrax and glanders have been transmitted although these diseases are fortunately rare at the present time.

During castration of animals suffering from botryomycosis, veterinary surgeons have become infected with the disease. Necrobacillosis, foot-and-mouth disease trichorrhexis nodosa, contagious pustular stomatitis, and dermatitis contagiosa pustulosa canadensis

are caught while attending diseased animals, chiefly horses and cattle.

Brucella eruption is not uncommon it has been found among about 30 per cent of the veterinary surgeons of Denmark. The affection appears shortly after handling the after-birth of diseased cows and is believed to be of allergic nature.

Urticaria and a papular dermatitis have been observed following vaginal operations on cows.

Nurses Orderlies and Attendants.—These workers are subject to many of the same risks as doctors from contact with patients and also from soiled bedclothes, excreta, and antiseptics.

Fig. 138 —Verruca necrogenica. Morgue attendant.

Nurses contract pediculosis scabies, and mycotic and bacterial infections. There is a high incidence of paronychia and carbuncles. Weak solutions of mercury sublimate have caused severe dermatitis and mercury ointment has produced stomatitis. A case is reported of a nurse with a persistent dermatitis due to the use of rubbing alcohol Creosote arsenic iodine, lysol chlorine alkalis, acids, and silver nitrate solutions are sources of irritation. Burns are not infrequent during the sterilization of instruments etc

Children's nurses are exposed to greater risks than those who attend adults, due to closer contact with the patients. Syphilis is a special hazard and multiple skin carbuncles, tinea circinata erysipelas, impetigo contagiosa pediculosis, pyoderma and blenorrhea may also be contracted while attending young children

Skin eruptions are frequently reported among orderlies, many from contact with hydrogen peroxide and iodine

Attendants in dissecting and autopsy rooms are subject to infections of various kinds from open cadavers, especially when small wounds are present Cases of septicemia are not infrequent. Contact with fixing solutions containing formaldehyde mercury chromates, or arsenic salts may cause dermatitis or even poisoning

In disinfecting stations fumes of formaldehyde sulphur and other substances produce irritation of the skin and mucous membranes. Carbon tetrachloride which is often employed as a delousing agent is a skin irritant.

Fig. 139 —Occupational dermatitis in morgue keeper due to formalin Positive patch test. (Case of Dr F P Lowenfish, Vanderbilt Clinic Columbia University New York.)

Fig. 140 —Radiodermatitis (occupational) in an x-ray tube maker (Collection of Dr Howard Fox.)

Laboratory Workers.—Bacteriologists and laboratory workers are subject to a wide variety of cutaneous and systemic diseases from

contact with drugs and chemicals, experimental animals, urine, blood, feces, bacteria, and fungi through accidental contamination. For example:

Erysipeloid has been reported due to dissecting the bodies of birds, and tularemia from handling diseased animals. The bites of animals produce traumatic lesions and may also transmit disease. The bacilli of tuberculosis are sometimes spread by flies when infected sputum is left uncovered and thus workers may become inoculated. Coccidioidal granuloma has been contracted during the course of laboratory research on this disease.

Fig. 141.—Dermatitis in chemist due to contact with chlor-aceto-nitril. The contact was on the hands which became inflamed a few hours afterwards. The face, neck and remainder of the body became involved about one week after original contact with the chemical.

Handling such substances as mercury, phenylhydrazine and arsenious acid has caused dermatitis. Discoloration, softening, and fraying of the nails with boring pains in the fingertips, inflammation, suppuration, and bullae have been reported as the result of contact with formalin. Bacteriologists may become sensitized to the dyes used for staining tissues. Crystal violet, methyl violet, Bismarck brown are some of the dyes used for staining which may cause allergic dermatitis. In fixing tissues, formaldehyde may cause dermatitis. Bacteriologists should wear rubber gloves when handling irritant chemicals and diseased tissues.

Radiodermatitis and cancer occur among technicians and workers exposed to roentgen-ray and radioactive substances. Technicians

who develop roentgen-ray films, etc. may suffer dermatitis from the developing chemicals.

Bursting of glass vessels and apparatus, fires and explosions cause wounds and burns.

Druggists and Pharmaceutical Chemists.—The sources of cutaneous disease in these industries are practically innumerable, and only a few of the more common can be indicated here. The substances handled are of vegetable, mineral, and animal origin, and are capable of producing dermatitis.

Vegetable material may be toxic in itself or may carry pathogenic fungi or acari. Scabies and other forms of acariasis have been acquired by chemists and druggists from brains and plants. Sap and essential oils of numerous plants such as mustard, pyrethrum, orris root, cinnamon, ginger, citronella, camomile, and senna may cause dermatitis. (For an extended list see chapters on Plants and Woods and Drugs.)

FIG. 142.—Occupational dermatitis in chemist due to chromium. Patch test positive to potassium bichromate. Photograph of patch test. (Case of Dr. A. Ross Smith, College of Physicians and Surgeons, Columbia University, New York.)

Alkaloids such as strychnine, brucine, atropine, apomorphine, morphine, codeine, cocaine, opium, and quinine often cause skin irritation. Workers who boil cinchona bark for pharmaceutical preparations suffer intense itching and smarting of the hands, arms, and face followed by erythema, edema, and confluent vesicles. Bullous pemphigus-like eruptions have been described among persons who work with quinine.

A chemist, a boiler, and a sorter of ipecacuanha all developed dermatitis from *emetine*, and solutions of emetine have been known to cause urticarial lesions.

Prolonged contact with borax often causes chronic eczema both among handlers and users.

Arnica produces a spreading scarlet rash with edema and exudation at the areas of contact among some persons.

Chemists are said to be especially liable to dermatitis which spreads from the original site to the face, scrotum, thighs, and other

parts from contact with phenylhydrazine hydrochloride. One case is reported of an itchy erythematous vesicular eruption due to wearing clothes soiled with this substance.

Washing cloths used as filters for morphine has caused an intractable dermatitis lasting over two years.

Formalin produces a contact dermatitis accompanied by severe onychia. (See Laboratory Workers.)

Skin eruptions have been caused by the preparation of plasters or tinctures of cantharides, and by handling hydrogen peroxide and iodine.

Intermediates in the manufacture of vitamins, in the manufacture of atabrine, atabrine itself, methyl bromide, a delousing agent, phenothiazine, and other substances too numerous to mention are handled by pharmaceutical chemists, which may cause dermatitis.

Other substances too numerous to mention here are handled by chemists and druggists. For a list of the organic and inorganic chemicals that may produce lesions of the skin, the reader is referred to the chapters on these subjects.

MIRRORS

The preparation of glass for mirrors is done by machinery. It is beveled by cutting, grinding, and smoothing with soft quartz sand, then soaped by further smoothing with emery powder. The glass is then polished with putty powder or fine oxide of iron (colcothar).

Old-fashioned mirrors were made by applying an amalgam of tin to the glass by the following method. A layer of tin leaf was spread on a table and mercury was slowly poured over it and spread with a piece of flannel to produce amalgamation. The glass was then placed on the bed of mercury, covered with flannel cloth and weighted down to make good contact. After three or four weeks the mirror was ready for use. This obsolete process produced many cases of mercurial poisoning; poisoning is sometimes incurred today by workmen who scrape the amalgam from old mirrors.

Silvering, which is the method now generally practised, consists of depositing on the glass a thin film of metallic silver obtained by the reduction of an ammoniacal alkaline solution of silver nitrate with an organic substance. The glass is then repolished with rouge, washed and heated at a temperature of 35° to 40° C. The silver nitrate solution is made alkaline with ammonia, which has the property of dissolving the silver oxide formed in an alkaline medium. As reducing agents, formaldehyde, essence of cloves and thyme, essence of camomile, sugar of milk, glucose, nitromannite, tartaric acid, and other substances are employed.

By the process of Brossette the deposit of silver is obtained from a solution of silver nitrate, tartaric acid, and ammonia heated to 40° C. After drying, the layer of silver is covered with a lacquer

such as gum dissolved in alcohol and a layer of varnish (benzene turpentine, linseed oil resins etc.)

Various methods are used to prevent darkening of the glass which is sometimes caused by the action of hydrogen sulphide despite the protecting varnish. By the Lenoir process the film of silver is partly replaced by a layer of silver amalgam. The silvered glass is washed and sprinkled with a weak solution of double cyanide of mercury and potassium. The silver is partially dissolved and replaces the mercury which becoming free, forms with the mirror silver an amalgam which is white and adheres firmly to the glass. This reaction is assisted by powdering with zinc dust.

In the use of silver nitrate and ammonia there is little risk to the workmen and the application of cyanide solution in the Lenoir process is harmless if proper care is taken. Explosions may occur however from manipulation of ammoniacal silver solutions. Such an accident has occurred through the action of organic dust on the precipitate formed by sodium hydroxide introduced into a silver solution concentrated by evaporation.

Pigmentation of the skin accompanied by nervous and digestive disturbances often result from contact with silver nitrate in this industry. Many of the workmen rub sodium cyanide into the skin with their fingers to remove silver nitrate stains and unless carefully washed off and removed from under the finger nails the substance may be carried to the mouth and ingested. Cases of cyanide poisoning from this source have been reported in mirror factories.

Many of the other substances employed such as ammonia formaldehyde essential oils of cloves thyme and camomile glucose and the resins and solvents in lacquers and varnishes are capable of causing contact dermatitis.

MUSICAL INSTRUMENTS AND MUSICIANS

Industrial Processes.—The manufacture of musical instruments involves the use of many irritating woods and the cutaneous hazards are similar to those of cabinet makers.

Pianos and organs are made of rosewood satinwood walnut mahogany birch spruce maple poplar etc all of which may be irritating to sensitive skins. (See chapter on Plants and Woods.) The black keys are made of ebony or grenadilla wood although other hard woods are utilized for the cheaper instruments. While the white keys are often pure ivory artificial substitutes are frequently used. These may be made of a composition of ivory débris and mineral substances held together by glue or of such substances as cellulose or galalith a casein made from milk and hardened with formaldehyde (galalith is also used in surgery for absorbable anastomosis buttons).

Sources of dermatitis are sawing blocks of ebony or grenadilla wood as well as the working of irritating woods for the cases. Lead poisoning has been reported among solderers, varnishers, and

bronzers of piano frames and also among workers on pipe organs. Acid dipping electroplating brazing and welding subject the workers to the risk of dermatitis paints and lacquers are also potential irritants. (See the various subjects for fuller details.) Ivory piano keys are bleached with hydrogen peroxide or sulphuric acid and sodium peroxide this may also produce dermatitis. Organ keys are generally left unbleached

The keys of the piano-accordion are made of celluloid bleached with calcium chloride and often dipped in glacial acetic acid to avoid hand polishing Dermatitis may occur from both these sources.

Violins and similar instruments are made of spruce or maple the fingerboards and tailpieces of ebony The bows are generally made of cocobolo The instruments are manufactured for the most part in European countries and are carved by hand Gut for the strings is sometimes dressed at the gut works by the violin makers themselves, and dermatitis has been reported from contact with salt used in the preparation of the strings. Varnish glue and lacquer are other sources of irritation

Most of the woodwinds (flutes clarinets oboes, bassoons piccolos etc.) are made of ebony or grenadilla (cocus wood) but sometimes ivory or silver is used and clarinets may be made of ebonite, another source of cutaneous irritation (See Rubber) Mouthpieces are generally of ebonite or reed

Drums are made of maple, mahogany steel or brass with a covering of calf or sheep skin drum sticks are of cocobolo wood

Horns, cornets, trumpets, trombones, tubas saxophones, etc are made of brass that comes to the factory in sheets and is machined polished lacquered and in some cases silvered or nickel plated at the factory Polishing is a prolific source of dermatitis due to the materials used Cases have been reported from the use of rouge (ferric oxide) some of them quite intractable. The authors, however have not seen such cases and patch tests with rouge in several cases have been negative. The fatty substances in polishing pastes and solvents used for the final scouring such as benzene benzine, methyl alcohol turpentine etc may provoke dermatitis. Amyl acetate is present in lacquers used for brass Before applying the lacquer the brass is cleansed by dipping in nitric acid Filling the instruments with molten lead before shaping sometimes causes lead poisoning

In electroplating with nickel or silver ulcers and fissures of the hands occur from benzine, petroleum lime, chalk, concentrated solutions of soda, and other substances used to clean the metals this is done at several different stages of the process. A preparatory cleaning with hydrochloric acid causes fissures of the palms and swelling soreness, and erosion of the fingertips. After cleaning the metal is dipped in potassium cyanide or hydrochloric acid scoured and placed in the nickeling vat A vesicular eruption of the hands, arms, and sometimes of the whole body occurs during nickel plating This is attributed by some authorities to the nickel

sulphate and cyanide of potassium in the electrolytic baths, and by others to the substances used for cleaning

In silver plating the articles after similar cleansing are dipped into a bath of sulphuric acid and mercury binoxide and afterwards treated with cold solutions of potassium cyanide and corrosive sublimate.

In soldering brass for the various instruments hydrochloric acid and lead are encountered

Musicians.—Harpists, violinists and other performers on stringed instruments incur callosities of the fingertips that often become infected They also suffer from muscle cramp of the fingers accompanied by pain and swelling that often result in long periods of disability The pain is greatest in the thumb and index finger but frequently extends to the palm wrist and even the shoulder Small subepidermal hemorrhages may form a red patch on the fingers and the skin around the nails becomes inflamed. The condition results from overstrain

Eczematous patches around the joints and folds of the fore-fingers sometimes result from sweating and friction which occurs among musicians, particularly pianists and violinists. Pianists occasionally suffer from atrophy and loosening of the nails of the left little finger and the right thumb due to excessive pressure on the keys. Among violinists callosities appear not only on the left hand from friction with the strings, but also on the right hand from pressure of the bow Muscular hypertrophy of the forearm that holds the instruments usually the left and increased length of some fingers of the same hand are stigmata of violinists. Callosities sometimes occur on the left lower jaw from pressure of the chin rest and keratosis at the point has been attributed to the same cause or to irritating ingredients in the varnish such as resin anthracene and acridine The formation of a fibro-fatty pad on the jaw has also been reported in a violin player Dermatitis has occurred on the fingers from contact with a mixture of rosin and pitch used on the bow

Paralysis of the distal phalanx of the left thumb is frequently seen among drummers, and chronic tenosynovitis of the long extensor of the thumb is said to result from the position of the hands in manipulating the drumsticks. The tendon has sometimes ruptured under the exertion of rolling the drum The cocobolo wood of which drum sticks are made is a potential source of dermatitis.

Wearing down of the teeth especially the incisors is observed among players of wind instruments they are also troubled at times with spasm of the tongue and the muscles of the larynx. Small scaly patches and annular excrescences on the lower lip and occasionally eczema are seen among flute players due to the irritation of mouthpieces made of cocus wood

Occupational syphilis may be contracted from the mouthpieces of instruments played previously by an infected person

OPTICAL WORKERS

Lens grinders may suffer from dermatitis of hands, arms and face caused by exposure to lens grinding fluid. This fluid may be alkali solution or turpentine and oil mixture. Prevention consists of wearing rubber gloves (fingerless) and impervious sleeves and aprons. A water-insoluble type of protective ointment may be used on the face.

PAINTER. SEE PAINTS AND VARNISHES

Painting is done either with a brush or with a spray painting gun. Those painting with the hand brush usually paint with paints in which solvents and thinners of the turpentine and petroleum distillate group are used and they usually work in places where there are no special exhaust ventilation systems to remove the solvent fumes.

Painters using the spray gun usually work in spray paint booths equipped with suction exhausts and the thinners in the paints are usually the esters such as amyl acetate and acetone. Spray painters should be told to spray toward the exhaust vents and not away from them.

Painters should wear protective sleeves, aprons and gloves and use a protective ointment of the solvent repellent type on the face (See Protective Ointments.) An occasional case of sensitivity to the pigments in the paint may occur

PAPER MANUFACTURE

Paper is made from wood rags and straw (See Pulp page 864.) The logs are cut into small chips by a revolving steel disc and are conducted into digesters, where they are cooked in a solution of hot sodium sulphide and sodium hydroxide (green liquor) This disintegrates the wood and dissolves out the pine tar resins and oils. The pulp is transferred to washing tanks and the digestion liquor (black liquor) is strained off Sodium sulphide sodium sulphate and sodium hydroxide are recovered from the black liquor

The pulp in water (1 per cent pulp in the water) is purified by running through "rifflers" and screens. It then goes through a series of "beaters" which reduce the size and fray the ends of the fibers. It then goes through a mixing tub where it is "sized" by mixing with rosin soap and alum The Jordan refining machines ready the pulp for the paper machine

The chief skin hazards in this industry are alkali burns and alkali dermatitis. Lime calcium bisulphite sodium sulphide, sodium hydroxide are all primary skin irritants. The black liquor and the green liquor are hot and contain strong alkalis which can cause either burns or dermatitis.

The pine tar rosin and oils are sensitizers and can cause allergic dermatitis.

In some plants sulphuric acid is made as a by-product and is an additional skin hazard

Workers around the digesters and other places where there are strong alkalis should wear impervious sleeves and aprons and take shower baths after work.

PASTRY COOKS

This occupation brings the workers into contact with cutaneous irritants in the form of sucrose glucose, fruits, nuts, various flavoring and coloring materials, etc. Dermatitis venenata is the most frequently reported occupational disease in this trade

The most common lesion is a diffuse eruption of pinpoint to pinhead-sized vesicles on an erythematous base located on the dorsa of the hands This has been observed for over a hundred years and described as grocer's itch or baker's psoriasis. (See Bakers.)

An impetiginous eruption due to glucose has been reported on the hands, forearms legs and feet Erysipeloid on the fingers and hands similar to that affecting cooks, has been described It consists of a dark red or livid inflammation accompanied by burning sensations.

The nails and periungual tissues are frequent sites of irritation Paronychia and onychia are prevalent among workers handling candied fruits. Authorities differ as to the exact cause but it is believed to be due to fungous infections. (See chapter on Diseases of the Nails—"Sugar Onychia.") Dried fruits sometimes harbor a mold which produces itching Yeast fungi in certain fresh fruits and molds found in an inferior grade of oranges cause dermatitis, paronychia, and onychia. (See chapter on Mycotic Infections.)

The essential oils of citrus fruits such as lemons oranges, bitter oranges, tangerines etc are irritating to some skins, and cause severe pruritus with erythema and edema that may be followed by vesicles and crusts.

Vanilla pods colored and preserved by cashew nut oil (cardol) cause dermatitis venenata, which we believe to be due to the splashing of this oil on the skin rather than to the acarus commonly found on the pods.

Nitrobenzol (oil of mirbane) used as an artificial bitter almond is extremely irritating to the skin.

Dermatitis and blistering due to angelic acid of angelica or cow parsley used in candying occurs among sensitive workers

Vesicular eruptions have been reported from contact with cinnamon oil of cassia cashew nuts, and Brazil nut

Chemicals used in dyeing protecting and artifically ripening fruits may cause dermatitis. Some workers acquire sensitivity after prolonged contact with such treated fruits (See chapter on Plants and Woods.)

Inhalation and ingestion of sugar and flour dust is believed to be responsible for the carious teeth often with accompanying gingivitis, which are prevalent among confectioners and pastry cooks.

Burns from hot ovens and utensils, scalds from boiling liquids, etc. are common

PENCIL AND CRAYON MANUFACTURE

In considering the health hazards of the lead pencil industry the first thought that is likely to come to mind is "lead poisoning" It cannot be too strongly emphasized here that lead in any form does not enter into the manufacture of "lead" pencils. The grayish black substance that marks the paper in writing is a mixture of graphite and certain kinds of clay

Graphite is a form of carbon found in the earth large quantities of which are used in the manufacture of crucibles for the fusion of metals and metallic alloys, to make large electrodes for electric furnaces and carbons for arc lamps. Manipulation of the substance cannot be regarded as a cutaneous risk. The substance appears to be non-toxic, although one case of pneumonoconiosis has been reported in the literature. This occurred in an elderly man engaged in grinding graphite for fifty years. He died from an accident, and a postmortem revealed no signs of pulmonary tuberculosis. Graphite dust was present in the lungs and bronchi

In the manufacture of pencils, graphite is mixed with clay and water and the mass ground in a mill It is then placed in a filter press and subjected to great pressure This produces a firm dehydrated mass which is placed in heavy power-driven presses and forced through an aperture of the desired shape and diameter for making the "leads." It issues from the presses in thin plastic strings which are laid on boards to dry When thoroughly dried the leads are sealed in crucible boxes and fired in kilns at a temperature of 600° to 1200° C to vitrify the clay

Slats of cedar (*Juniperus virginiana*) are cut into widths which are mechanically planed and grooved in several parallel lines. The lead is laid in the grooves and the strip of wood covered by another strip whose grooves exactly fit the rondure of the lead The two sections of wood are glued together and transferred to automatic shaping machines which cut them into single pencils The pencils are finished with a coat of lacquer

For making colored pencils a basis of kaolin is blended with suitable waxes and gums, and ground together with the necessary coloring materials, aniline or chromium compounds. Firing is not done. Methyl violet is blended with graphite to make the ordinary purple indelible pencils, and aniline colors are used for copying pencils. Arsenic colors are said not to be used for this purpose at the present time

Since pencils are made almost entirely by automatic mechanical processes there are very few cases of skin disease among the workmen. Dust is carried off by exhaust ventilation and sawdust from

the woodworking operations is drawn off beneath the machines by suction apparatus. The graphite mixture is handled only as it passes into the presses and after it emerges in the form of strings. In the case of colored mixtures there is, of course, a possibility of irritation from aniline or chromium compounds.

In cases of dermatitis among pencil factory workers, if an occupational origin is suspected, the possible causes to be considered are: Heat from the crucibles, sawdust of red cedar wood, arsenic (improbable), aniline colors, chromium colors, waxes and gums (in colored pencils), glue and its solvents, lacquer and its solvents (especially pyridine).

Colored chalks are made of ordinary pipe clay or chalk moistened and kneaded with the various coloring materials, rolled out and pressed into wooden or metallic molds, and dried slowly at a low temperature.

Crayons are a mixture of coloring matter with pipe clay or wax molded and enclosed in wood or wrapped in paper.

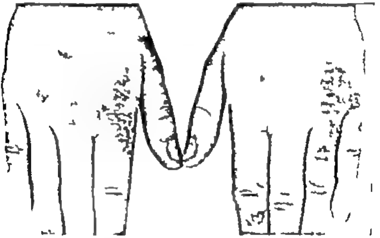


FIG. 143.—Dermatitis in a teacher due to colored chalk. (Case of Drs. Foerster and Wieder.)

Indelible oil crayons for sketching on glass, porcelain, etc., are composed of tallow and wax with gum arabic and coloring matter. The colors are mixed with fats in warmed vessels, levigated, and allowed to cool until they have reached the proper consistency to be transferred to the presses in which the mass is treated and shaped in the same way as the graphite for ordinary pencils.

School teachers may develop dermatitis of the terminal ends of thumb and index fingers from the dyes in colored crayons.

PHOTO ENGRAVERS AND PHOTOGRAPHERS

Photo-engraving includes photography on photographic films, photography on zinc and copper plates, etching of metals. The

skin hazards are from photofilm developers, such as metal, paraform aldehyde, hydroquinone from ammonium dichromate used to sensitize metal plates and from the acids used in etching. The resins (Dragon's blood) used to protect the plates in etching rarely cause dermatitis.

Photo-engravers using developers, bichromates and acids should wear long rubber gauntlets and impervious sleeves and aprons. If protective ointments are used they should be of the water repellent type. (See Protective Ointments.)

PICKLE MAKERS

These workers come in contact with brine, acetic acid, vegetable juices, some of which not only macerate the skin but are primary irritants (such as the juices of strong peppers) and sensitizers (such as the juice of carrots). (See Canning and Food Preserving.) Lactic acid formed in the fermentation vats may also cause dermatitis. Pickle workers should wear rubber gloves, impervious sleeves and aprons and clean work clothes daily.

PICKLING METALS

Pickling of metals consists of dipping them in acid solutions (H_2SO_4 or HCl) in order to remove scale. After the acid dip the metals are dipped in water to remove excess acid. Sometimes they are dipped into a solution of lime (Ca OH) following the water dip and then allowed to dry, leaving deposit of lime on the metal. The dry lime powder acts as a lubricant when the metal is further processed. Picklers are exposed to splashes of acids and lime and should wear protective impervious aprons, rubber gauntlets and rubber boots.

PLATE PRINTERS

Dermatitis among these workers is caused by exposure to the dyes and inks used on the plates, the petroleum solvents used to clean the presses, and the solvents and strong abrasive soaps used to remove the dyes and inks from the hands. The custom of smoothing the inks over the plates with the bare palms should be abolished and a method devised for doing this which does not entail soiling the hands. The cleaning of the presses should not be done by handling kerosene soaked cloths or sponges, and the use of solvents and abrasives for cleaning the hands should be discouraged. Dyes can be removed from the skin by dipping the hands in a 1 to 1,000 solution of potassium permanganate, followed by dipping in a 5 per cent solution of sodium sulphite and then immediately washing with a sulphonated oil and water. Emollient creams containing lanolin may also be used after work to keep the hands in good condition.

PLUMBING, GAS AND STEAM FITTING

(SEE ALSO BUILDING CONSTRUCTION)

Plumbing includes all metal work used in the installation, fitting, repairing, soldering, etc., of pipes and fixtures for water, gas, steam, drainage, refrigerating and air-conditioning systems, and on cisterns, roofs, and other parts of buildings.

The metals employed are iron, steel, lead, tin, zinc, copper, brass, and bronze. Lead pipes were formerly used almost entirely and are still to be found in old buildings, although during the last three or four decades they have been largely replaced by iron or copper, which are preferable to lead because of their greater strength and resistance to hot liquids. For soil pipes, however, lead has the advantage of smoothness, adaptability, freedom from corrosion, and soundness when jointed with wiped solder joints. An alloy of lead and tin is used for wash bowls, traps, etc. Copper or brass is generally used for hot and cold water pipes.

For internal work, lead is jointed by soldering with wiped joints, copper is brazed, and iron is welded.

Pipes for gas are usually of wrought iron or steel with fittings of the same material or malleable iron. They are joined with screw joints, the threads of which are smeared with a lead and oil compound.

Drains are of heavy cast iron or steel and provided with ventilating pipes, usually of galvanized iron, to remove gases and to protect the water seals or traps. Access covers are made airtight with greased felt washers.

Installing hot water apparatus for domestic use includes the fixing of boilers, storage vessels, and circulating pipes and the insulation of pipes and vessels with asbestos to prevent loss of heat.

For beer engines, pumps, and spirit pipes, block tin pipes are used; the joints are of the cupped variety known as "blown joints." The solder contains bismuth to lower its melting-point so that a surface alloy can be formed at a temperature below the melting point of the pipes.

Chemical plumbing consists of the erection and jointing of large chambers of heavy sheet or plate lead, the manufacture and fixing of large pipes for conveyance of acids and gases, covering earthenware cocks, lining vessels, etc. Lead is the most desirable material for this work because of its resistance to acids. Joints are made by melting lead and fusing the edges with the addition of extra lead to strengthen the seams and joints.

Plumbing includes metal work on roofs such as lead for gutters, flashings, covering for dormer windows, stone cornices, domes, turrets and other ornamental work, watertight joints between slate or tile roofs and brick walls, chimneys, etc. Cast lead and milled sheet lead are generally employed for roof work.

Copper also is used for roofing, making tubes and flashings, lining tanks and kitchen boilers, etc.

Tin is used to plate iron for roofing lining wrought iron or steel pipes and tanks, and in chemical laboratories to pipe distilled water

Bronze is highly resistant to corrosion and is therefore desirable for piping soft water

Steel columns and constructional work are often covered with cast lead to preserve the metal and to improve the appearance of the structure this also comes within the province of plumbing

Wrought iron pipes are largely used for plumbing in ships the welding being done by oxyacetylene flame.

Workmen engaged in the manufacture of lead pipe and solder and other plumber's supplies composed of lead are exposed to poisoning from fumes and dust. Plumbism from these sources is now infrequent due to the installation of hoods and exhaust ventilation in the factories. (For risks involved in the manufacture of plumbers supplies from copper brass, bronze, tin zinc, iron and steel see these subjects.)

Plumbers and gas and steam fitters are subject to the toxic effects of lead while cutting and filing lead pipes, bends, and traps and in making joint connections with white or red lead

Solderers are exposed to fumes not only from lead but also from hydrochloric acid and zinc chloride which often produce dermatitis and ulceration of the hands. Gasoline used in the blow-torch may be a source of injury to the skin and burns may occur from the flame or from hot soldering irons.

Arsenical poisoning may occur during the operations of brazing and galvanizing from arseniuretted hydrogen in the hydrogen used for the blow-torch.

Cast iron pipes are caulked with "O K.A." a mixture of tar and rope, and over this hot lead is poured Contact with tar may cause lesions of the skin. (See Tar)

Mercurial poisoning and dermatitis are possible from soldering galvanized iron pipe with lead-mercury solder (See Mercury)

Pipe fitters come in contact with red lead white lead and various lubricants such as glycerine

Finishers who connect fixtures to the pipes encounter white lead in the joint compounds and use hydrochloric acid to clean fixtures.

Oppenheim has described a lesion among plumbers resulting from cold produced by carbon dioxide discharged from a cylinder plus tattooing by rust blown against the forearm from the gas cylinder and pipes.

Roofers are exposed to the hazard of dermatitis from soldering and to acneform eruptions from handling tar

Strong soaps and grease solvents such as gasoline used to clean the hands, are potential sources of dermatitis.

Repairmen who work in old buildings encounter a special risk from lead since old plumbing consists almost entirely of this material They are also subject to extraneous hazards such as bites from rats and insects that often infest the premises.

A case has been reported of a plumber bitten on the arm by an

insect while repairing pipes in an old building The lesion resembled a boil and required repeated excision after which a similar eruption appeared on the opposite arm

Sewer workers are exposed to infectious diseases such as spirochetosis icterohemorrhagica (see Bacterial Infections) bites of rats and insects, and to poisoning from sewer and illuminating gas.

Ditch workers and roofers are both exposed to inclement weather and may suffer from the effects of heat sunlight and cold (See chapter on Physical and Mechanical Agents.) Ditch workers who lay underground pipes are subject to frost-bite in cold weather Tetanus or ankylostomiasis may be contracted from the soil

POLISHERS

Polishers are subject to skin hazards from most of the chemicals contained in polishes. Metal polishers use acids alkalis abrasives and cyanides. Wood polishers use polishes containing soap or other alkalis, oils and waxes. The hand and lower forearm are usually affected Polishers should wear leather gloves whenever possible. They should use only mild soaps, or sulphonated oils for cleaning the hands, and an emollient cream containing lanolin should be rubbed into the hands after work.

POTTERY

(Cement—Clay—Ceramics—Chinaware—Porcelain)

The raw materials used in the pottery trade are clay flint and feldspar The feldspar acts as a binder between the flint and the clay There are various kinds of clays used for different kinds of china such as English China clay Florida clay Georgia clay and Ball clay The Ball clays are darker in color than the other clays due to the content of lignite, iron coal and other organic coloring matters

Definite amounts of the various substances are weighed out in troughs and placed in a machine called a blunger where they are mixed with water and made into a mud or "slip The slip is further mixed and then passed through silk screens called lawns to remove the coarser particles. It is then run over a magnetic separator to remove the metallic iron next into another mixing machine called a smooth agitator and then pumped into filter presses where the water is pressed out The soft moist material is then passed through a machine called a pub mill and extruded through a die in the form of a continuous cylinder The cylinder of clay is cut into suitable lengths and the material is then ready for use

The only skin hazards in the operation thus far are dermatitis and folliculitis from the dust in the storage and weighing departments.

The next process is forming the ware from the clay and is called "jiggering" A piece of soft clay is placed in the mold or on the

mold as the case may be and revolved A piece of metal called a "tool is brought in contact with the revolving clay to mold it to the required shape and thickness. The men who work at jigger ing often have the skin of their fingertips tender and eroded from friction against the wet revolving mass of clay After jiggering the wares are passed through a drier to remove the moisture are placed on containers called saggers," loaded in cars, rolled into the kilns, and fired at a temperature of over 2000° F The cars travel slowly through the long kilns, requiring two or three days to make the passage. This is called the bisque fire After the bisque fire the wares are ready for glazing

The glaze consists of lead boro-silicate, lime zinc, and sodium carbonate. It is made in a furnace by melting boric acid borax lime feldspar and flint into a glass and then quenching in water This is ground in the mill with lead carbonate, zinc oxide clay feld spar flint, and water into a liquid glass. The pieces can be hand dipped in the glaze or the glaze can be applied by spraying

Workers who hand-dip the glaze may develop a dermatitis from the alkali in the glaze or they may be sensitive to the substances contained therein. When the glaze is applied by spraying, it is accomplished by placing the wares on a traveling chain behind a glass shield where the glaze is sprayed on There is usually a suction vent to draw off the excess spray and protect the workers against the lead

After the glaze is applied the wares are again put on saggers and fired in the kiln to put on what is known as the ghost fire

If the wares are to be colored they are dipped in a colored glaze containing metallic oxides of chromium cobalt, copper iron or uranium Sometimes the pieces are decorated by hand A varnish is applied with a hand brush and decalcomania designs are stuck on and stamped down with a brush. The decals are made of the same flux as the glaze Fine lines of color are also put on with a hand brush The girls who apply decalcomania sometimes develop dermatitis from turpentine, decaline, and tetraline used in the varnish or for cleaning the brushes. Wares are also decorated by placing the color on with a rubber stamp After the wares are decorated they are again fired to fix the decorations and color

The colors and decorations on chinaware, although consisting of poisonous metals cannot possibly come off and cause harm to the users because they are insoluble in water and are calcined at high temperatures with silica and clay If soluble in the slightest degree the colors blot and designs having clear lines cannot be obtained

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PULP PAPER, AND PAPER PRODUCTS

Wood rags and straw are the chief materials from which paper pulp is manufactured The pulp may be made in paper mills or in separate factories.

Rags of linen and cotton scraps of rope string etc. come to the factory in bales, are cleaned by beating then sorted and shredded in a special machine which is often combined with a mechanical drum washer Cleansing is done with a solution of quicklime caustic soda or a mixture of sodium carbonate and lime After boiling the water is drained off and the rags passed on to a breaking *machine or beater in which bleaching with calcium chloride* may also be done They are then washed with water which is drawn off the remaining pulp is known as 'half-stuff

Straw of wheat, oats, barley alfalfa esparto and rye is ground freed from dust and impurities by a current of air and boiled under pressure The pulp is then bleached with caustic soda

Wood which is the most important material used for paper making is derived generally from fir pine larch poplar beech or birch It is made into wood pulp or 'half-stuff' by mechanical processes or by treatment with caustic soda lye sodium sulphate or bisulphite or steam under pressure.

In the first case the logs are cut into suitable sizes and the bark removed by a machine called a barker which tumbles the logs against each other They are then defibered by passage through a rapidly revolving mill and carried by a current of water through a series of grinders and sieves until the pulp is of the required consistence.

In the sulphate process barked logs of 5-foot lengths are passed through a chipper which cuts them into small chips. Kettles are charged with the chips and a solution of caustic soda then closed and heated under pressure for a few hours The rosin tar and liquid are dissolved out of the wood by the caustic soda leaving only the cellulose The solution known as 'black liquor is drawn off and the softened wood dumped from the kettles into vats called diffusers to be washed with water It is then passed through a series of disintegrating machines and beaters to be defibered into fine pulp suspended in water The pulp is rolled and dried or stored wet. The black liquor is treated with sodium sulphate the resulting solution is then evaporated and the residue calcined in a closed rotary calciner This converts the sodium sulphate partly into caustic soda and partly into sodium sulphide. The calcined mass is extracted with water and is again ready to act on more wood in the digester In this process gases of a disagreeable odor are

given off and hence factories must be located at considerable distances from towns

In the bisulphite process the wood chips are boiled in a solution of calcium bisulphite in brick or cement-lined closed kettles, the spent liquor drawn off and the softened wood treated as described above. The liquor is treated with lime and sulphur dioxide resulting in the formation of more calcium bisulphite which is again used to act on more chips.

When treated by the caustic soda process the chips or shavings after boiling are subjected to high pressure in a pulp digester Caustic soda lye is added and the mixture brought to a high temperature. The pulp is washed in tanks or a washing machine and the lye is recuperated and concentrated about 70 per cent being recovered.

The steam process consists of treating the wood with steam under pressure. The half-stuff which is used principally to make wrapping paper is left unbleached and has a brownish color

The chemicals used in these operations are usually prepared in the pulp factories. The caustic soda is made by the action of lime on soda ash and workers who shovel the lime and soda ash in and out of the storage bins often suffer from dermatitis and ulcers

Calcium bisulphite is prepared in a tall tower which is filled with limestone. Sulphur dioxide gas made by burning pyrites is allowed to pass into the bottom of the tower and at the top it encounters a spray of water which results in the formation of calcium bisulphite ($Ca(HSO_3)_2$) This solution is highly caustic and capable of producing dermatitis and ulceration

In the sulphate process, ulcers and dermatitis are likely to occur from splashes of black liquor because it is not totally enclosed in certain parts of the reclaiming operation. In both the sulphate and the bisulphite processes splashes of the alkaline pulp from the grinders, beaters, and hollanders and also from the bleaching solutions may cause dermatitis.

Bleaching is done with calcium chloride chlorine fumes, or electrochemically Robertson has mentioned the possibility of chloracne among beatermen and bleachers of wood pulp The dust and fumes of caustic soda, lye quicklime, and other alkalis are likely to produce lesions of the skin mucous membrane and nails especially if the substances are hot or the skin perspired

Color is added to the pulp by aniline or mineral dyes. A finely powdered glass colored with cobalt blue is used for handmade paper Ochre yellow ultramarine blue, Prussian blue, and indanthrene blue are used for high-grade papers and methyl and ethyl violet blues, greens and reds are applied to newsprint papers.

Most papers are "loaded with clay calcium sulphate 'pearl hardening kaolin or china clay casein rosin gelatin, talc, ochre, etc. Ochre acts both as loading and coloring material.

Writing paper and other papers on which ink is to be used are

sized to make them less absorbent. For this purpose rosin rosin soap starch gelatin or waterglass (sodium silicate) are employed.

After the pulp is loaded sized and colored it passes onto a series of drying and polishing rolls to form a continuous sheet of polished paper which is automatically cut into the required sizes.

In modern paper factories the machines are automatic, and occupational dermatitis is rare among operators of the machines

Cardboard.—Cardboard is made chiefly from waste paper although some wood pulp is used for the better grades. The material is fed into a large tank like 'beater together with coloring matter size and alum for waterproofing and stiffening The beater s helper loads the stock into the machine usually by hand and adds the size alum color etc. It is treated in a Jordan machine or some other type of refiner and then goes to cylinder machines which consist of vats and cylinder molds. These turn out pasteboard consisting of several layers pressed together and cut.

These processes are generally carried out automatically in one huge continuous machine but in cases where sizing materials, alum and color are put into the machine by hand dermatitis may occur from contact with the various irritants.

Sodium silicate or waterglass, used for sizing liberates alkali on contact with water R. Prosser White has reported thickening and cracking of the skin ulcer and scars in a workman engaged in fastening pieces of cardboard together by means of liquid waterglass over a period of two weeks.

The manufacture of pulp and paper is not regarded as an unhealthful industry although the high temperature and humidity of the workrooms lead to irritation of the skin and excessive perspiration increases the susceptibility of the skin to alkalis and other irritating substances encountered in the work.

Traumatic injuries are rather frequent among workers who saw or cut the wood and remove the bark by machinery Burns occur from splashings of hot pulp in the processes of shredding and grinding

Dermatitis may occur from raw materials such as irritating woods and infection from contaminated rags. Large quantities of dust are raised during the sorting of rags and old papers.

In 1925 Semenow discovered among 18 samples of dust and rags taken from the sorting departments of several paper factories tubercle bacilli *Aspergillus fumigatus* and actinomyces. Nevertheless infectious diseases were not very frequent among rag workers due to the fact that the infective organisms lost their virulence to a great extent when the rags were stored in bales. Erysipelas appears to be contracted more often than other diseases in this work.

Straw is a potential carrier of acari and pathogenic fungi. Interdigital blastomycosis has been reported in the Province of Gifu Italy among workers making straw paper (See Mycotic Infections.) Infection among paper mill workers due to the *Aspergillus niger* or *flavus* has also been noted by some observers In the American

factories inspected by the authors, however no cases of fungous disease have been discovered.

The coloring agents employed in the manufacture of paper may cause eruptions but only small quantities are used and few workers handle them. On the other hand decorative coloring for the finished paper presents a hazard. The use of arsenic for coloring wall paper so common in the past, is now prohibited in many countries but aniline and chromium compounds may cause trouble among wall paper printers. Bronzing powders, mica and wool dust are also irritants unless adequately removed by exhaust ventilation.

In preparing paper and papier maché for export it is usually treated with formaldehyde which constitutes another source of dermatitis.

Arsenical compounds employed in the glazing of paper may produce dermatitis.

According to the United States Department of Labor Bulletin No. 582 published in 1933 the chief sources of constitutional and cutaneous risk to pulp and paper makers are as follows:

Heat and humidity	Chlorine
Sudden changes of temperature	Formaldehyde
Dampness	Hydrochloric acid
Arsenic and its compounds	Sodium hydroxide
Arseniuretted hydrogen	Sulphur dioxide
Sulphuretted hydrogen	Sulphuric acid

Paper Box Manufacture.—In making boxes of paper and pasteboard the workers are almost constantly in contact with moist glues and pastes which give rise to numerous cases of dermatitis.

The process known as "stripping," i. e. pasting paper strips on the sides and tops of the pasteboard forms, is done by a machine but in many plants the machines are not automatic and require some hand operations. A long strip of paper cut to the proper size by a scoring machine passes through a bath of liquid glue and is fixed to the pasteboard form by the stripping machine. The worker tending this machine used the fingers to guide the strip and in consequence the fingers, especially the right index, are constantly coated with moist glue. Numerous cuts occur from the sharp edges of the paper become filled with glue and infection frequently follows. Cuts also occur from the sharp edges of dried glue.

Glue and paste are mixed at the plant to secure the various consistencies necessary for different weights of paper and during this process splashing of the hot mixtures on the bare skin is another cause of dermatitis. (See Glue.)

The manipulation of colored papers and painting fancy boxes subjects the workers to irritation from the coloring materials. (See Paints, Dyes, etc.)

PUTTY MANUFACTURE

Putty is made of *different* ingredients according to the purpose for which it is intended. A simple mixture of whiting (calcium car

bonate) and linseed oil is ordinarily used by carpenters, painters and glaziers. However, this tends to dry up and fall apart unless lead is added. Hence, where a strong durable putty is required, white lead, red lead, or litharge is added.

Waterproof putties are made by mixing powdered lead with thick linseed oil varnish until it forms a stiff paste. This putty is used for tightening gas pipes, for rivet seams on gas meters, hot water furnaces, and other metal work. Or, for the same purpose, equal parts of white lead, manganese, and pipe clay are mixed with the linseed oil varnish.

An extremely firm waterproof and heatproof putty, used for fixing glass panes in aquariums, etc., is made of concentrated glycerine mixed to a soft paste with finely pulverized litharge. This putty hardens so quickly that it cannot be manufactured in quantity, but must be mixed on the job as required.

Other waterproof putties are composed of slaked lime, linseed oil or heavy spar varnish, and powdered graphite. In some mixtures, small proportions of tar and rosin are added.

A glazier's putty for fixing glass into window, picture, or mirror frames is made of gum elastic dissolved in enough benzine to make a syrupy mass, to which is added a stiff paste consisting of white lead and linseed oil varnish. Or, caoutchouc is dissolved in benzol and mixed with the lead and linseed oil paste.

A hard black putty consists of finely powdered antimony sulphide and whiting mixed with waterglass (sodium silicate). Another mixture contains boiled tar or soft pitch and raw linseed oil in equal parts mixed with china clay.

For steel sashes, a firm putty is made with the following ingredients: Domestic whiting, 100 pounds; Belgium whiting, 80 pounds; sublimated blue lead, 23 pounds; reduced fish oil, $4\frac{3}{4}$ gallons; boiled linseed oil, $1\frac{1}{4}$ gallons; and white oil drier, $\frac{1}{2}$ gallon.

Putty powder, used for polishing metal, glass, and Japan work and also to color opaque white enamel, is made by melting tin with an equal weight of lead, and then pulverizing.

The chief occupational hazard among putty makers is lead poisoning. Cases also occur among carpenters, glaziers, painters, picture frame makers, metal polishers, and enamelers who use putty powder.

Dermatitis results from contact with the numerous irritants employed in the manufacture of putty. Among sensitive workers, linseed oil may produce an itchy papular eruption followed by crusts. The irritating effect of solvents such as benzine and benzol are well known, and that of carbon disulphide is considered a special risk of putty makers. The eruption caused by carbon disulphide is characterized by blackish irregular ecthymatous patches, erythema, vesicles, and scaling.

Antimony sulphide in black putties may produce dermatitis (see chapter on Antimony), and tar and pitch may give rise to acneform lesions or folliculitis. Waterglass may produce ulcers through wounds, caused by the hardened substance, which are irritated by

the dust. Such cases have been described by R. Prosser White in cardboard factories where waterglass is used.

Glycerine may cause dermatitis among sensitive workers, and slaked lime and the various gums and resins employed are potential irritants. Irritation is also possible from the dust of sodium silicate in preparation of whiting.

RAG SORTERS

These may develop infections taking the forms of pyodermia, boils and lymphangitis from germ laden rags. Occasionally a case of dermatitis may occur due to allergy to dyes in the rags. (See Synthetic Dyes.) Rag sorters should take showers after work and have a daily change of clean work clothes.

REFRIGERATION

(Ice Making, Cold Storage, Air Conditioning)

The artificial production of cold is employed in industry chiefly for three purposes: (1) The manufacture of ice, ice cream, etc. (2) cold storage and food preservation in packing plants, refrigerator ships, freight cars, vans, etc. which transport perishable goods, and (3) the conditioning or cooling of air in theaters, cinemas, stores, hospital wards, mortuaries, railway coaches, passenger ships in the tropics, etc.

Cold is used in the chemical industry for drying, extracting, and freezing; in breweries, yeast factories, malt houses, dairies, sugar refineries, distilleries, dye works, and textile mills. In the mining industry to solidify shifting earth or wet sand, and for numerous other industrial purposes.

When a liquid changes to vapor or gas, heat is drawn from surrounding objects whose temperature is thereby reduced. Ammonia is commonly used because of its cheapness and the low temperature at which it can be converted into a gas. The process in bare outline is as follows.

The gas is compressed, passed through a condenser (a system of pipes over which water is poured) to be cooled and liquefied. The liquid, though cold, boils as soon as it can expand. On passage through refrigeration pipes, the pressure is reduced and the liquid evaporates, and absorbs heat from any substance (air, water, or articles such as foodstuffs) around the coils. Again in the gaseous state, it flows back into the compressor and the whole process is repeated.

The necessary machinery consists of a steam engine, oil engine, gas engine, or electric motor.

In ice making, the freezing tanks are filled with brine which is cooled by the ammonia below the freezing-point of water, although the brine does not freeze. Cans filled with water are placed in the tank where the water is frozen solid. The cans are then placed in hot water by means of a hoist, emptied, and the blocks of ice trans-

ferred by a conveyor to a storage room which is equipped with ammonia pipes along the ceiling to prevent melting

In cold storage plants or cooling systems, the ammonia or other refrigerant circulates through coils inside the rooms to be cooled. By varying the amount of liquid ammonia in the coils the temperature desired may be maintained

Ammonia is the chief refrigerant in ice and cold storage plants, and is dangerous on account of leaks and explosions.

Carbon dioxide is safer and for that reason is more frequently used in air conditioning of theaters, hospitals, etc. Solid carbon dioxide known as "dry ice" is used to some extent instead of ice in refrigeration for railway cars and by ice cream dealers. Contact with the dry ice or carbon dioxide "snow" may cause frost-bite after brief contact due to its extremely low temperature.

Air may also be cooled by passing it through sprays of water or over pipes filled with water brine or other cooling substance. It is then circulated in the room to be cooled by means of air ducts. Or pipes containing cold air water or brine may be installed in the room itself These methods are used when very low temperatures are not required

Sulphur dioxide is employed to some extent for general refrigeration in Great Britain and Europe. The gas is non-explosive but dangerous because of its irritant action

Methyl and ethyl chloride may be used The escape of these gases through leaks is difficult to detect however

The chief hazard to the health of workers in refrigerating plants is the sharp changes of temperature. The ill-effects of cold are greatly increased by the presence of humidity which is often impossible to eliminate during the manufacture of ice

Another source of danger is the leakage of gases which being under pressure escape in large volume through the smallest leaks. Explosions may occur from excessive pressure and ignition of the fumes at the moment of escape. Mineral oils used to lubricate the compressors may be transformed by high temperatures into hydrocarbons and form inflammable or explosive mixtures Static electricity may also be a factor in the production of explosions.

The workmen may develop frost-bite, particularly of the feet from working in a damp and very cold environment e g refrigerating chambers Frost-bite of the ear has occurred among porters who carry blocks of ice or frozen materials on the shoulder Dermatitis and chilblains may develop after prolonged contact with very cold parts of the machinery or refrigerating pipes e g while making repairs.

The authors have seen a case of Raynaud's disease in a man in whom attacks of painful blanching of the fingers were provoked by handling frozen fish

Burns occur not only from explosions but also from ammonia which escapes in a jet. Lachrymation, conjunctivitis, and keratitis may also result.

Ammonia or sulphur dioxide in the air irritates the mucous membranes and passages.

Serious cases of poisoning sometimes death may result from the fumes of methyl chloride and other refrigerating agents.

RICE FIELD WORKERS

Rice is cultivated in warm climates and in localities where the soil is marshy The fields are periodically drained and inundated again with water which at the time of weeding stands from 20 to 25 cm. deep The water is almost stagnant and is rank with putrescent matter from uprooted weeds, manure and the remains of aquatic animals.

Constant steeping of the hands and feet in water which ranges in temperature from 64.4° F (18° C) early in the season to 96.8° F (36° C.) later on, lowers the resistance of the skin to trauma and infection. Fatigue, muscular aches, sunstroke blepharitis conjunctivitis, and malaria occur frequently due to exposure and working conditions. Open wounds and rhagades readily become infected Septicemia and tetanus have been reported as a consequence of such infections. Schistosomiasis is a skin and systemic hazard.

Callosities frequently occur on the hand used to uproot weeds. First there is a wearing of the skin, and this may be followed by erythema, breaks in the skin and suppuration. Later the epidermis becomes hypertrophied to form a true callosity which often becomes fissured

About the middle of May when the water is comparatively cold vasomotor symptoms suggestive of Raynaud s disease are observed in the extremities. The skin of the hands and fingers, especially the thumb and index finger becomes pale, opaque and hypesthetic. A few hours later there is a sensation of heat and bluish erythema. Later in the season when the water is hot, the skin of the feet and legs becomes red edematous, and painfully fissured.

At the beginning of the season, before the skin has become weakened by submersion in water whole shifts of workers are sometimes attacked by rice worker s dermatitis which is localized to the parts in contact with weeds and water The affection is attributed to pricks from the weed *Ammannia major* and *minor* complicated by infection from scratching (See chapter on Plants and Woods.)

Acari, particularly the *Pediculoides ventricosus* may attack those who clean sort, pack, unload transport, or otherwise handle the grain, and dust may *cause irritation of the mucous membranes and* conjunctivae (See Flour and Grain Industry) Injury of the cornea from spicules of rice are frequent during the harvest season

Weeding rice which *causes the most injury to the skin is mostly* done by machinery although hand labor is also common. The workers should protect their exposed parts by the use of an ointment and rubber boots before entering the water

ROOFERS

Roofers may develop dermatitis from building cement, from heavy coal tar distillates or pitch from asphalt tar paper asbestos and paints which they use in building roofs making them water proof and fireproof. Photosensitivity and dermatitis from the pitch and heavy coal tar distillates are probably the most frequent dermatoses in this trade. (See Coal Tar.) Folliculitis acnes, melanosis and occasionally epithelioma may be caused by the heavy coal tar distillates among roofers. Roofers should have a daily change of clean work clothes, take shower baths after work and use a protective ointment on the face which acts as an actinic ray screen if they are exposed to pitch dust or fumes.

ROPE AND CORDAGE MANUFACTURE

The materials used in the manufacture of rope twine bagging canvas, etc. are hemp jute Manila sisal Phorium aloes, cocoanut fiber and for some purposes esparto grass and straw. Of these hemp and jute are the most widely employed.

Hemp (*Cannabis sativa* and *indica*) is dried stripped of its leaves by beating made into bundles, and retted in running or stagnant water for a number of days. It is dried again and sent to the breaking machines, after which it undergoes several cleaning operations. In all of these processes except retting considerable amount of dust and débris is shaken out.

Heckling is another dusty process which is usually carried out in open sheds and often necessitates a canvas screen between the machines and the workmen to keep off the dust. In some plants heckling is done by hand with a coarse comb to remove the large stalks and some thick tow. The raw hemp is then sent in bales to the factory to be made into rope or spun into coarse cloth.

The preparation of hemp is an unhealthful occupation. The great abundance of dust containing a high percentage of silicious matter the toxic alkaloid cannabine and sometimes sulphur which forms on fibers that have been retted too long or in stagnant water causes tonsillitis bronchitis and other respiratory diseases as well as dermatitis.

Hecklers, in particular have been said to develop a characteristic appearance due to their dusty work. It consists of emaciation brownness of the skin stooping shoulders, and retracted abdomen. The use of mechanical hecklers has considerably lessened the practice of hand combing and these stigmata are rapidly disappearing.

The dust raised in stripping off hemp leaves produces a generalized erythema accompanied by itching and burning. While not severe, this condition often exposes the skin to secondary infections. During the manipulation of the fibers the dust causes an eczema on the hands and behind the ears which is similar to that seen among flax workers.

In the process of retting, the workers are obliged to wade into the tanks of water which is often stagnant. By the time the bundles are taken out, the water has generally become putrid containing sulphuretted hydrogen and giving off a nauseating odor Maceration of the skin of the legs and feet leads to many small traumatic injuries which result in eczema often accompanied by deep painful wounds onychalysis, and loss of the toe nails.

Jute comes from several species of *Corchorus* cultivated most extensively in Bengal and Assam. Like hemp it is retted in running or stagnant water after which the bark is removed by hand It arrives at the factories in the form of a mass of fibers of various qualities and colors and is treated in much the same way as hemp except that the fibers are softened at an early stage by impregnation with oil. Fish oil, petroleum oil, and soap solutions are often used for this purpose. Some of the fibers are bleached with sodium carbonate or hypochlorite, and some are dyed

Jute dust appears to contain no such noxious ingredient as the cannabine of hemp but nevertheless it often causes an illness known as "mill fever which is characterized by violent coughing, bronchial catarrh and prostration The symptoms last two or three days and frequently clear up without treatment.

Dermatitis occurs among workers who boil the jute in solutions of soap and sodium and potassium hydroxide, and also among the dyers. Workers who handle the threads impregnated with solutions of yellow soap impure fish oil, and mineral oil develop an eruption consisting of erythema and swelling eczematization papillary hypertrophy and often suppuration

Among the native workers in India who fail to use detergent soap sufficiently for cleansing their hands a non-suppurative folliculitis due to the coloring materials and oils is frequent.

Some cases of tetanus have occurred in jute mills due to spores carried in the soil that clings to plants imported from India.

The finest quality of rope is made from the fibers of Manila hemp obtained from the Abaca tree, a species of banana plant which grows in the Philippine Islands. Sisal comes from the leaves of the Henequin plant which grows in Yucatan It is used to make cheap rope and twine containing splinters of the stiff fiber These plants do not seem to contain any skin irritants.

On opening the bales and shaking out the raw materials when they arrive at the rope factory quantities of dust arise. After opening and shaking the fibers are run through an emulsion of oil and water in the softening machines, and then through a carding machine. Even though the fibers are oiled carding raises much dust. The hemp is spun on a frame having a funnel-shaped condenser to regulate the thickness of the strand fed to the fly spindle which does the twisting

Cables are made by "laying machines that warp and twist the threads to form strands, while other machines twist several strands together to form the cable. Some types of machines form the

cables directly. Fine string is made by machines which pass the fiber through a bath of dressing or dye and wind it into balls.

Various dressings are applied to rope and string according to the purpose for which they are intended. For marine use hemp rope is treated with boiling tar, and old rope and fibers used in the manufacture of oakum are similarly treated. Tar itch and lesions of the nails are frequent among workers engaged in these operations and, as in all work with tar, epithelioma may develop after prolonged contact. Weiss has reported a basal-cell epithelioma of the forehead and a prickle-cell epithelioma of the scrotum in an elderly ropemaker engaged for thirty-eight years in impregnating rope with pine tar.

Many cases of dermatitis arise from the dust, impure oil, and dyes with which jute and other raw materials are impregnated.

Ropes for agricultural use are often treated with a mixture of fuel oil, 95 per cent, and wool oil, 5 per cent, to soften the fibers and protect the rope from being devoured by insects. Contact with this oil produces acneform lesions, especially in warm weather.

R. Prosser White reports thinning of the skin of the thenar eminence of the right hand among twine finishers and polishers, and atrophy of the left hand among twine ballers.

In common with other jute and hemp workers, rope-makers show a high incidence of tuberculosis and pneumonia.

ROUTER OPERATOR

These workers operate an electric cutting tool used in cutting designs out of metal sheets. The router often throws oil with which it is lubricated and oil acne and folliculitis may occur among routers. They should wear impervious aprons and sleeves and take showers after work.

SACK MAKERS AND SACK FILLERS

These sometimes develop dermatitis from the lint that comes off the jute sacks. Impervious sleeves (the arms and face are mostly affected), a lanolin type of protective ointment, and cleansing showers after work are preventive measures. In a sugar refinery where dermatitis was occurring among those serving and filling jute bags, the trouble was controlled by dipping the bags while being held open into a weak solution of rubber cement and drying. This kept them from shedding lint.

SHEET METAL, STAMPED AND ENAMELED WARE

For making articles such as stoves, bathroom fixtures, advertising signs and novelties, kitchen utensils, etc., sheet iron and steel are prepared so as to be especially adapted for deep stamping and enameling. The metal must contain a minimum of impurities to prevent excess breakage. A suitable soft steel is made by either the

Bessemer or the open-hearth process and contains foreign substances in about the following amounts

	Per cent
Carbon	0.08 to 0.12
Phosphorus	0.04 or less
Manganese	0.30 to 0.50
Sulphur	0.05 or less
Silicon	0.025 or less

The metal is made into sheets in the usual way by alternate heating and rolling until the required thinness is obtained. After rolling the sheets are pickled for a short time in a bath of sulphuric acid containing approximately 5 per cent free acid at a temperature of about 180° F to remove all mill scale formed by the rolling process. They are then washed in a water bath to remove the acid and subjected to an annealing operation under cover at about 1400° F for fourteen to sixteen hours. When annealed and cooled, the sheets free from mechanical defects which might interfere with the enameling process are sorted out.

Iron requires higher temperatures for melting and more intensive open-hearth treatment to eliminate the impurities. The metal must be very ductile, adapted to deep drawing and contain no blisters or irregularities of texture.

The sheets of metal are then stamped and shaped by special machines. During this process the ware always collects grease from the machinery and the workmen's hands, and all the grease and carbonaceous matter must be removed before pickling is done. The following processes are used for cleaning

Scaling or heating to red heat with sufficient aëration during the operation to oxidize completely all the carbonaceous matter

Immersion in a boiling solution of sodium or potassium hydroxide to remove the fatty materials. The article is then washed with clear water Some of the cleaning preparations on the market consist of sodium hydroxide, sodium carbonate, borax trisodium phosphate, sodium silicate, soaps, and rosin. This method of cleaning is, however suited only to ware that has not become heavily coated with oil during the shaping process.

For large ware or special shapes that cannot easily be cleaned by pickling, sand-blasting is done. This removes the grease, rust, and all foreign matter at the same time.

After the oil and carbonaceous matter have been eliminated it is necessary to remove the oxide of iron which is always formed on the surface of steel in the process of scaling and annealing For this purpose the ware is pickled in sulphuric or hydrochloric acid before the enamel is applied.

Pickling vats are often in the form of double tanks of soft pine with a 2-inch space between the inner and outer walls which is filled with melted pitch These tanks, however are not suitable for heated solutions.

Some tanks are lined with lead but these are easily destroyed by rough contact with the articles to be pickled Cypress tanks

braced with wood are the most satisfactory Iron bracing is rapidly destroyed by acid vapors and when it gives way it is almost impossible to stop the leakage

Both cold hydrochloric acid and hot sulphuric acid used for more rapid action give off dangerous fumes that should be drawn off by fans. Niter cake, composed of acid sodium sulphate is extensively employed as a pickling medium

In order to prevent acid vapors from rising from the vats some factories cover the surface of the acid daily with a film of flour bran or other mill products. As these organic substances become charred by acid they form a blanket of charcoal and foam over the liquid which retards the escape of hydrogen gas and acid fumes.

The ware must be placed very carefully in the vats so that every part of the surface is covered A sludge of iron scale soon collects on the bottom of the tank.

Electric pickling consists in passing an electric current through the acid during pickling using the iron articles as a cathode

The ware is rinsed in clear running water after it comes from the pickling vat and is then immersed in a weak solution of soda ash at boiling-point.

There are numerous formulæ for enamels which vary according to the articles to be enameled and with the different processes adopted Lead enamels are quite distinct from the leadless types. Opaque enamels generally contain 40 to 50 per cent of lead and also a certain amount of arsenic. These often form the first coat to be applied to pottery (See Pottery)

Ceramic enamels used chiefly to cover relief castings and produce the appearance of enameled pottery generally contain 55 to 70 per cent of lead and sometimes 1 to 5 per cent of arsenic.

Sanitary enamel ware generally contains no lead or arsenic.

Enamel for metal signs and advertising novelties contains lead and usually some arsenic.

The pure raw materials ordinarily used in enamels are as follows

Aluminum	Calcium carbonate and phosphate
Antimony oxide	Carbonate of lime
Quicklime (calcium oxide)	Calcium fluoride
White lead	Fluorspar
Basic lead carbonate	Bone ash
Lead oxide (yellow)	Chromium oxide
Litharge	Cobalt oxide
Lead oxide (red)	Iron oxide (red)
Minium	Magnesia
Barium carbonate	Magnesium carbonate
Boric acid	Manganese dioxide
Boric oxide	Black oxide of nickel

Enamels generally used for sheet iron are composed of the following substances

Silica (sand ground quartz)
Feldspar
Borax (B_4O)

Cryolite (Na_3AlF_6) (sodium fluoride, 60 per cent, and aluminum fluoride, 40 per cent)
Fluorspar (CaF_2)
Barium carbonate ($BaCO_3$)
Zinc oxide
Sodium and potassium salts (trioxide tetroxide and pentoxide)
Compounds of antimony
Bone ash
Manganese dioxide
Cobalt oxide
Nickel oxide
Copper oxide
Tin oxide
Clay

Color is produced by the various oxides e g cobalt gives blue manganese, violet copper and chromium green iron brown and so on Calcium carbonate is used in connection with antimony oxide to give a good cream color

The materials are finely ground and mixed either by placing a batch of about 500 pounds in a box and turning it over a few times with a hoe or shovel or by means of rotating drums or other mixing machines.

The mixture is then placed in a smelter and fired until every ingredient is dissolved After cooling it is pulverized and placed in boxes and barrels for future use.

In preparing enamel slips for application to the ware the frit is ground wet and contains 5 to 10 per cent by weight of plastic clay To give viscosity to the slip and aid in holding the enamel in suspension a flocculating agent is added consisting of magnesium sulphate or borax.

The enamel is applied to the ware by slushing draining spraying or dusting, according to the shape and size of the article Slushing is simply dipping the article in a highly viscous enamel slip and turning it to produce an even coating Draining is used for flat pieces such as signs and simple shapes. The piece is dipped into the slip, set on edge and allowed to drain For large and complex pieces the enamel is sprayed on Dusting is commonly done for cast iron work and also for heavy steel pieces. The enamel powder is dusted onto the article which has previously been dampened often with the addition of some adhesive substance

The enameled articles are then fired in a muffle furnace or an open-hearth furnace if the ware is of heavy steel After the first coat is fixed a second coat is applied in the same way

Although enamel may be manufactured and applied in the same factory the two processes are often carried out in separate plants. Risks to the skin and health are far more numerous during enameling than in manufacturing the material

The incidence of lead poisoning is high in this industry It may be incurred while preparing the enamel from the dust given off when red lead or minium is put into the mixing apparatus or when the furnace is charged from above Charging from the side

is less dangerous as the dust is carried away from the workmen by the draught. Whitish lead-bearing fumes which later disseminate dust are given off when the furnaces are too hot. Quantities of dust arise in the process of crushing the enamel unless it has been thoroughly fritted *Barreling and boxing the pulverized enamel is* a very dusty operation which should be done mechanically in closed apparatus.

Not only is there danger from lead in these dusts, but also from arsenic antimony chromium and chromates which may produce dermatitis as well as systemic poisoning

In the course of application the most dangerous operations are immersion of red hot articles and sprinkling on the powdered enamel The men generally work in scanty clothing and are covered with sweat, facilitating skin absorption of lead and the development of dermatitis.

In 1927 Leathers and Morgan reported that out of 45 workmen in a Nashville stove factory engaged in enameling medical examination revealed only 13 who showed no symptoms of lead poisoning Protective measures were entirely lacking in the factory up to that time but have since been provided

Adequate ventilation, frequent washing of walls floors, and benches and automatic machinery for the various operations minimize the risks from dust and fumes, and some processes such as crushing the raw materials may even be done under water in certain cases.

While lead and its compounds constitute the greatest hazard other substances and working conditions may give rise to lesions of the skin. Excessive dry heat from the furnaces or from large articles to be enameled causes erythema, pigmentation, and eruption on some skins.

Goglow in 1931 observed mild erythema with slight scaling ulceration and nail changes on the hands of enamel factory workers Skin tests (Jadassohn and Bloch) showed specific sensitivity to the enamel mixture and its filtrate.

Barres and Courtois-Suffit described corrosive ulcers on the skin of enamel workers due to the alkalis or acids used and the same condition was observed in a workman engaged in cleaning articles with sulphuric acid applied with a brush Ulceration of the skin was reported on the fingers of women workers who dipped articles into the liquid enamel and was supposedly due to penetration of the skin to a depth of ½ mm by particles of the materials. The ulcers occurred mainly in the deep folds of the skin and some of them were covered with a tenacious brown crust. The exact ingredient which produced this condition was not determined but the lesions resembled those caused by quicklime.

Dermatitis may result from contact with tetrachlorethane which acts as a powerful solvent of organic matter and also causes severe constitutional symptoms often ending in death

The substances that may produce dermatitis among enamel workers are as follows

- Amyl acetate
- Antimony and its compounds
- Arsenic and its compounds
- Benzene and its homologues
- Benzine
- Carbon disulphide
- Chromium and chromium compounds
- Hydrochloric acid
- Lead and its compounds
- Manganese
- Naphtha derived from coal tar for the preparation of colors
- Nitrous gases and nitric acid
- Quicklime
- Sulphuric acid and its fumes
- Tetrachlorethane
- Turpentine

The hazards encountered by workmen engaged in the preparation of articles from sheet metal are heat in the processes of refining and annealing oil in the machine operations acids used in pickling, caustic alkalis for scouring, and hot pitch in certain types of pickling vats. Sheet metal workers often do welding and soldering (See Welding and Soldering)

SHIPBUILDING AND RAILROAD EQUIPMENT MANUFACTURE

The cutaneous hazards incidental to the manufacture of machinery and building construction are present in these industries. They include dermatitis from contact with various woods, metals rubber paints, oils, resins tar and solvents and are described under these headings.

Oil acne and folliculitis are the most frequent skin lesions. The Bureau of Occupational Diseases of Ohio also mentions 8 cases of chrome ulceration among makers of automobile parts and accessories in 1037

SHOE MANUFACTURE

Workers making shoes occasionally develop allergic dermatitis from tanning agents and dyes in the leather But most of whatever dermatitis occurs in shoe manufacture is caused by the solvents used for the cements which cement together parts of the shoes and by the shoe dressings and cleaners used by the finishers and treers, who put the final finish on the shoes. To prevent dermatitis from cements and shoe dressings the workers should be instructed to apply them with spatulas and brushes, so as not to soil the hands.

SOLDERER

Solderers occasionally develop dermatitis from exposure to hydrochloric acid and zinc chloride which are used as flux Rosin flux is used in some soldering operations. In soldering stainless steel

silver and aluminum a flux containing fluorides is used Dermatitis and nasal mucitis can be caused if the vapors from the hot soldering iron dipped in the flux come in contact with skin or nasal mucosa Solderers should be instructed to insert petroleum jelly into the nostrils several times a day and to keep the face away from the fumes coming off the soldering iron A protective ointment of the lanolin type may be used on the face

SPICES AND FLAVORING AGENTS (MANUFACTURE)

Spices used to season or flavor foods, confectionery liqueurs, etc. are grown in the tropical regions of both hemispheres and have a world wide distribution Pepper is the general term applied to several pungent spices which are derived from different plants.

Black pepper is the most widely used of all the spices It comes from the unripe dried fruit of *Piper nigrum* grown in Penang the islands of Riouw and the vicinity of Singapore which is the great spice exporting center It contains a pungent resin a volatile oil that imparts the flavor and a yellow crystalline alkaloid piperine which has the same empirical formula as morphine ($C_{17}H_{19}NO_3$) but different constitution and properties.

White pepper is derived from the ripe fruit of the same plant which is dried for three days then bruised and washed by hand to remove the stalks and pulpy material. Or the outer layer of the dried black pepper is removed leaving the remainder white

Long pepper is the fruit of *Piper officinatum* of the Indian Archipelago and *P longum* from Ceylon Malacca and the Malay Islands.

Ashanti or West African pepper is the dried fruit of *Piper clusii*

Joorman's pepper *Polygonus punctatum* is found in England It may produce dermatitis.

Melegueta pepper known as Guinea grains grains of Paradise, or alligator pepper is the seed of *Ammomum melegueta* a plant of the ginger family

Cayenne pepper (Guinea pepper Spanish pepper or chilli) is made from the dried fruit of various species of *Capsicum* chiefly *Capsicum annuum* a plant of South America The pepper is manufactured from the ripe fruits which are dried and mixed with wheat flour and made into cakes with yeast. The cakes are baked until they are hard and are then ground and sifted Or it may be made by simply drying the pods and pounding them in a mortar Chillies are used to make pickles and chilli i e vinegar

Allspice consists of the dried fruit of *Pimentum officinalis* (*Eugenia pimenta*) a tropical American tree

Cloves are the dried flower buds of the clove tree (*Eugenia caryophyllata*) a native of the Spice Islands. The leaves, flowers and bark are all aromatic The fruit which resembles an olive has a weaker flavor but is used to some extent under the name of mother of cloves.

Cinnamon is obtained from the dried inner bark of an oriental tree *Cinnamomum zeylanicum* cassia, of similar but inferior flavor is derived from other varieties of *Cinnamomum*. Both contain a powerful irritant, *cinnamic aldehyde* which causes dermatitis.

Nutmeg is the kernel of the fruit *Myristica fragrans* or *moschata* and other related species indigenous to the East but cultivated in tropical countries all over the world. The exterior consists of a succulent pear-shaped fruit which is often preserved as a confection The inner envelope of the kernel makes the spice known as mace.

Ginger is the rhizome of various species of *Zingiber* chiefly *Zingiber officinale*

All these spices contain essential oils and are capable of irritating the mucous membranes of the eyes and respiratory passages and many of them irritate the skin. The dust which arises during the process of grinding spices acts mechanically as well as chemically to produce dermatitis. In addition, since the authors have seen cases of urticaria from ingestion of spices, it is possible that ingestion of dust containing spices may cause urticaria among allergic workers.

Oil of anise which is derived from the fruit of *Pimpinella anisum*, has produced dermatitis consisting of erythema, moderate scaling and vesiculation. The irritating agent is anethol (paramethoxyallyl-benzene, $C_{10}H_{12}O$) of which the oil contains 90 per cent. Anise is extensively used for flavoring liqueurs confectionery etc.

Mustard comes from the ripe seeds of *Brassica nigra* (black mustard) and of *Sinapis* (*Brassica*) alba (white mustard) When the seeds are crushed and moistened irritating volatile oils are liberated from the glucosides.

Vanilla is produced from the ripe fruit of *Vanilla planifolia* Orchis family The whole of the plant is toxic and produces among workers who handle it a clinical entity known as vanillism This disease is characterized by constitutional symptoms of headache vertigo somnolence, and other disturbances and by a rash on the face, hands and neck consisting of edema, erythema and papules. The eruption is very itchy and resembles erysipelas. The symptoms which occur among cleaners and sorters of the beans have been attributed to acari or molds. However other cases have developed when these possible causes were absent, and this has rendered suspect both the oil contained in the pods and cardol which is sometimes used to color and preserve the pods. (See chapter on Plants and Woods.)

Conjunctivitis and blepharitis are caused by the dust of vanilla. Sticks of vanilla are often placed in alcohol and contact with the tincture sometimes causes erythema and other eruptions on the skins of sensitive workers. Vanillin, a benzaldehyde which appears on vanilla in the form of crystals, is a skin irritant that causes a burning sensation and has been held responsible for the dermatitis. Vanillin may also be produced synthetically from eugenol and coniferin and this preparation has been known to cause eczema in

a patient insensitive to natural vanilla. Chemists engaged in the manufacture of vanillin are frequently affected by it.

The essential oils of citrus fruits used to make flavoring extracts produce dermatitis. Certain oranges infected by molds cause mycotic paronychia and erosion of the nails. (See chapters on Plants and Woods and Mycotic Infections.)

Oil of bitter almonds and the artificial oil of bitter almonds (oil of mirbane) produce irritation of the skin.

Many herbs are employed for flavoring and seasoning in Europe and the United States. Chief among these are fennel, basil, balm, dill, caraway, mint, parsley, sage, thyme, marjoram and savory. As a rule the leaves are used, although in some cases the roots or seeds are found to be more pungent. These are prepared by drying and powdering, or by preserving in alcohol or vinegar. The essential oils of many of these herbs may irritate sensitive skins during the course of manipulation.

Certain of the irritants mentioned, such as vanilla, oil of bitter almonds, oil of cloves, nutmeg, orange, lemon, *et al.*, are also employed in the manufacture of perfumery (see Cosmetics) and cause dermatitis among workers in that industry as well as among those engaged in their manufacture. Cooks, pastry cooks and particularly confectioners are also exposed to the irritant properties of these spices and flavoring materials.

SPORTING GOODS

Leather, rubber, steel and wood enter largely into the composition of sporting goods. Many of the articles are of simple construction. Footballs are made of pigskin or cowhide and contain a rubber bladder pneumatically inflated. Baseballs consist of cowhide covering a core of rubber wound with twine.

Golf balls are somewhat more complicated. Those of the cheaper grade have a core of solid rubber around which many strips of thin rubber are wound. The ball so made is then placed in an outer shell of rubber, the two halves of which are welded together by vulcanization. The outer surface is sprayed with white paint.

A better grade of golf ball has an inner bag of rubber which is filled with a soft paste made of powdered white lead in some such vehicle as glycerine. After the bag is filled and closed, it is tightly wound with fine rubber strips and placed inside a rubber shell in the usual way. Other balls have a similar structure except that the filler is a liquid instead of a paste. Some of the fillers are made by a secret formula, although in at least one type of ball, the authors have been informed, the liquid is a solution of borax and resin in water. This solution is first frozen and then placed in the two halves of a rubber sphere which are joined together and vulcanized. Still another type of golf ball has a hard center consisting of curled hog's hair and Balata (a sort of rubber derived from the latex of *Mimusops globosa*).

In some cases golf balls are lacquered with preparations containing the following ingredients wet cotton dibutylphthalate butanol amyl acetate butyl acetate toluol dammar resin dissolved in alcohol and linseed oil.

No opportunity to inspect factories which manufacture sporting goods has been afforded the authors but the skin hazards to workers may be deduced as arising from leather rubber wood paints resins and solvents. Lead poisoning is a recognized danger in the manufacture of golf balls containing lead paste

Golf clubs are made of steel with leather-covered handles. The shafts are usually painted and the heads are often nickel or chrome plated. Dermatitis may occur in the process of plating or from the paints and solvents used

STONE WORKERS

(Miners, Dressers Polishers Sculptors)

The quarrying and mining of stone requires heavy labor which exposes the workmen chiefly to muscular injuries and accidents from falling rocks and explosives. *Callosities and hygromata on the hands* are caused by friction of pickaxes, spades and similar implements. Among laborers in alabaster mines, who have to carry blocks of stone long distances from deep underground quarries, a fibrolipoma covered with hair may develop on the weight bearing shoulder over the trapezius muscle Alabaster workers who operate a lathe are subject to a callosity over the upper surface of the right clavicle

Stone dressing includes cutting sawing shaping and carving by skilled workmen and sculptors. These processes, whether done by hand or by machinery and when carried out by the dry method liberates large quantities of dust which is responsible for the prevalence of respiratory diseases and a high death-rate from tuberculosis. Infections such as actinomycosis may also be transmitted by the dust, and ankylostomiasis by contaminated water

Stone dust causes irritation of the mucous membranes of the eyes nose and mouth and eczema of the external ear and the auditory meatus. Ulceration of the cornea and conjunctiva due to trauma from sharp particles is frequent among the workmen The particles may also penetrate and lodge beneath the epidermis, causing tattooing (See chapter on Physical and Mechanical Agents.)

The use of pneumatic tools, especially in cold weather often causes "dead fingers among stone dressers. The index and middle fingers become cold white and insensitive While the affection is not serious and soon clears up (often with a hyperemic reaction) it reduces efficiency Of greater importance are the hygromata tenosynovitis, and subcutaneous cellulitis which often result from operating these tools, and scleroderma of the hands due to the use of the chisel in cold weather Limestone and lime frequently cause

eczema of the hands involving the nails and interdigital webs, and infection may follow

Among stone polishers putty powder may cause lead poisoning and oxalic acid painful lesions of the hands and irritation of the mucous membrane at the back of the mouth

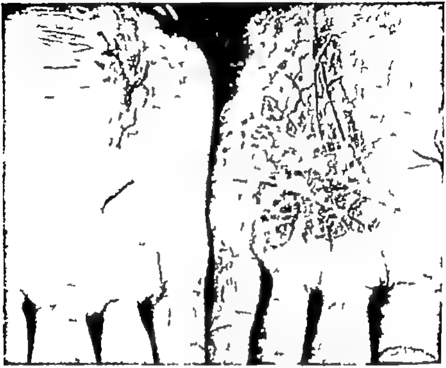

FIG 144 —Eczematoid dermatitis in a bricklayer (Case of Drs. Foerster and Wieder)

STREET CLEANERS AND GARBAGE COLLECTORS

Occupational morbidity in this work is far less than might be expected in view of the great amount of decomposed organic matter and dust with which the workers come in contact. Present-day methods of transporting garbage in a closed receptacle the decrease of animal soil in the streets, and the sterilizing action of sunshine and air on pathogenic organisms (particularly the tubercle bacillus) largely account for the comparative healthfulness of this employment.

According to the authors observations the most notable skin disease among street cleaners is folliculitis which results from the action of dust and dirt on the perspiring skin. Blepharitis and conjunctivitis due to wind and dust are not uncommon. In cold climates there is a risk of pernio and frost-bite during snow and ice removal especially in the presence of dampness. A number of

extra men are generally taken on for such work who are likely to be less resistant to the effects of cold than the regular workmen

TAXIDERMY

In this industry the skins are removed from animals as soon as possible after death The taxidermist uses special instruments and works with great care to avoid injury to the skin fur feathers or scales of the specimen which is to be mounted

The skins are cleaned and treated with various preservatives and then mounted over a model of the animal which has already been prepared from wood plaster cork conglomerate or other suitable composition. The open edges of the skin are sewn together around the form and the heads finished by the insertion of artificial eyes. The former practice of stuffing animal skins with straw or wool is now obsolete.

While removing the skin from the carcass the taxidermist may receive cuts from the instruments, and such wounds readily become infected from contact with diseased or putrid organic matter The fur also may transmit mycotic and other animal diseases the gravest danger being from the spores of anthrax Since however good specimens are most likely to be selected for mounting the risks from this source are probably minimal

The chief cause of skin disease in this work is contact with the cleaning and preserving materials. Strong soaps, lysol arsenious oxide Browne solution containing chloride of lime, solutions of mercuric chloride and mixtures containing tannin calcined alum etc. are used for these purposes, and all are capable of causing contact dermatitis. The skins are manipulated while wet with the different solutions, and after drying the poisons are liberated in the form of dust which may produce skin eruptions and also systemic poisoning through inhalation

Feathers and fur are sometimes cleaned with gasoline and afterwards powdered with plaster of Paris which is beaten off with a brush when it becomes dry These substances may cause dermatitis in the course of application and also when disseminated in the air as dust.

Arsenious oxide or white arsenic employed for curing the skins may be dissolved in boiling water to which soda is added or used dry with or without the addition of alum Numerous skin lesions are produced by treatment with arsenic. They usually consist of persistent ulcers of the fingers lesions of the nails, and eruptions closely resembling the dermatitis of furriers and tanners. This form of dermatitis may lead to the development of epithelioma.

THEATRICAL PROFESSION AND MOTION PICTURE INDUSTRY

The chief sources of cutaneous disease in this profession are unsanitary surroundings, the common use of costumes wigs, etc.

excessive use of make-up and the dust and dirt encountered while traveling and in ill kept lodging houses. Thus, scabies, pediculosis, and similar diseases may be contracted by using infested beds, bedding, costumes, etc.

In the same way syphilis and other infectious diseases may be acquired.

In many theaters wigs and costumes are thoroughly cleansed or sterilized before wearing and some employ a medical supervisor and nurses to render first aid and prophylaxis. However where no such protective measures are practised and among poorly paid traveling actors the hazards mentioned above still exist.

Motion picture and stage performers alike are subject to dermatitis from cosmetics which are used extensively. This is particularly true of motion picture actors who must apply large quantities for make-up to secure the desired photographic effects. For all such dermatitis, refer to chapter on Cosmetic Irritants.

Occupational stigmata in the form of callosities are seen on hands of acrobats and on the toes, especially the hallux of dancers.

Motion picture actors are exposed to a special danger from the brilliant lights under which they are obliged to work. To produce sunlight effects artificially powerful arc lamps gas-filled incandescent lamps, and mercury vapor lamps are employed. The light from these is rich in ultra violet rays as well as violet and blue rays all of which are irritating to the eyes and in lesser degree to the skin. Heat produced by the lamps is also a troublesome factor often causing a feeling of oppression.

The typical syndrome resulting from this cause is known as electric sunstroke. It begins with a swelling of the face especially of the eyelids which become reddened and feel prickly and sandy. The skin undergoes the changes characteristic of ordinary sunburn and results in desquamation and a brownish pigmentation that fades slowly.

The eyes, however are more seriously affected than the skin. The prickling sensations increase and are replaced by a dull pain. The conjunctivae become reddened and sometimes undergo inflammatory infiltration. This is accompanied by lachrymation and blepharitis with the formation of small crusts along the lid margins. In some cases changes in the macula and scotoma and vacciniform hydroa of the eye have occurred as sequelae. Photophthalmia with erosions and opacity of the cornea have also resulted.

The lesions of the eyes and skin are not confined to cinema performers but also affect mechanics technicians directors, and other assistants who work within range of the lights.

Prevention of these untoward effects of light is being studied but the problem is highly complex and at this writing still awaits solution.

The heat developed by the lamps causes heavy perspiration that tends to heighten the effect of any irritants in the make-up.

Stage Hands.—Stage hands may develop callosities of the hands and traumatic lesions from handling heavy properties and mechanical apparatus. Stage carpentry exposes the workmen to dermatitis from the irritants of certain woods to which some skins are sensitive (See chapter on Plants and Woods.) Electricians are subject to occupational burns and electric shocks. Scene painters run the same risks from lead paints, turpentine etc., as do other painters (*q v*)

Although photography involves contact with many irritants reported cases of dermatitis are relatively few in the film industry Developers such as metol amidol quinone hydroquinone phenylenediamines, adurol ortol and pyrogallol may provoke skin lesions, but they are seen only among persons with sensitive skin

Other potential irritants are chemicals used as sensitizers in color photography Among these are coal tar dyes some of which cause dermatitis by photosensitizing the skin for example eosin erythrosine, and rhodamine B Auramine, aurantia chrysoidine are dyes that can cause cutaneous lesions of themselves.

Ammonium bifluoride ammonium sulphide caustic soda formalin mercuric chloride and iodide and oxalic acid which are used for various processes in photography are capable of producing contact dermatitis. Platinum salts employed in plate toning irritate not only the skin, but also the mucous membrane of the upper respiratory passages. (For a full description of these and other cutaneous irritants, see chapter on Photography Photo-engraving Lithographing Printing etc.)

UNDERTAKERS AND EMBALMERS

Certain infections may be contracted from contact with cadavers, e g verruca necrogenica and extragenital syphilis

Embalmers may incur dermatitis from substances in the embalming fluid Although numerous preparations are used for this purpose the chief ingredient is usually formaldehyde Mercury is also listed by the United States Department of Labor as an occupational risk for embalmers.

Other substances irritating to the skin used in various embalming preparations are carbolic acid oil of cinnamon oil of cloves and thymol

UPHOLSTERING AND MATTRESS MAKING

Except for a few minor operations hand work is still the rule in these trades. The feathers down straw horsehair felt (compressed wool and hair) cotton kapok and excelsior used for the stuffing of furniture cushions mattresses and pillows generally reach the factory in a clean and sterile condition This is particularly true of imported horsehair and wool which in most countries are disinfected at the port of entry to prevent the possible spread of anthrax. Where sterilization of material has not been ade-

quately carried out or not done at all the workmen are exposed to certain hazards.

Feathers.—From raw feathers parasitic and other diseases of birds and fowl may be transmitted. Slight wounds of the skin are likely to become infected by contact with organic dust. Even after sterilization the materials used to cure bleach and disinfect feathers are capable of causing dermatitis in the course of manipulation. (See Feather Industry.)

Cotton.—In some of the larger mattress factories cotton is received in bales and carded on the premises. In such cases mycotic infections may be incurred by workmen who open the bales which are laden with dust sometimes contaminated by molds.

Kapok.—This is a vegetable substance derived from the fruit of certain plants belonging to the Bombacaceæ and indigenous to the West Indies, Indo-China Japan Central and South America, and other tropical countries Its long silky fibers are used extensively in the upholstering of furniture and the filling of mattresses cushions, pillows, automobile seats, and life-belts.

The fruit is opened by hand and the wooly contents or "kapok down" removed It is then sorted to eliminate any discolored or mildewed fibers. Cleaning and removal of seeds are done by ginning The oil from the seeds is used in the manufacture of margarine and soap while the cakes provide feed for cattle. The cleaned kapok is winnowed in a current of air and falls like snow over the workmen For some purposes kapok is dyed by dipping in coloring solutions (direct basic acid or sulphur) The finished product is put in bales like cotton

The dust raised in ginning and winnowing kapok fills the air with a thick fog and produces a peculiar kind of discomfort in the nose and throat. Moreover the workmen who shovel it are often buried up to the shoulder in the soft fine fluff Sclerosis of the lungs has been demonstrated by roentgen-ray among these workers due to inhalation of the dust even in the absence of clinical symptoms.

Excelsior —This material is produced in planing mills chiefly from poplar pine and basswood and is marketed in bales without further treatment. Irritation or gradual sensitization of certain skins is possible from handling this material especially if it is freshly cut. (See chapter on Plants and Woods.)

Straw —The special risk met with in working with this material is from itch mites that sometimes infest it Epidemics of "grain itch" have been reported from time to time among workmen who make straw mattresses or otherwise handle straw The rash consists of pruritic urticarial lesions which later become vesicular or pustular and may be accompanied by a low fever

Horsehair —Although animal hair imported from foreign countries is always under suspicion as a source of anthrax infection is rare at the present time due to stringent government regulations regarding sterilization In the past industrial anthrax has been alarmingly frequent. In France 4 cases have been reported among

mattress makers alone between 1910 and 1922 and 5 cases in 1923 Due to the highly resistant nature of the spores danger to users from this source should still be taken into consideration.

Wool.—Raw material from India, Turkey Asia Minor China Africa and some other counties may likewise carry the spores of anthrax and other diseases common to sheep and goats may also be transmitted to workers who handle wool Mycosis due to the *Aspergillus nigricans* and *flavescens* has been reported in woolen mills. It may be said however that these risks are slight among upholsterers and mattress makers who are not likely to come in contact with unsterilized wool.

Although workmen handling disinfected wool have in the past suffered from eczema due to formaldehyde used to treat the material, means have been found to eliminate this risk. Within recent years wool for mattresses has been treated with a barium chloride solution which is believed to remove impurities not eradicated by the ordinary methods and to make the mattresses more resistant to moths and other vermin.

The steel springs in mattresses and upholstery are generally brought to the factory ready made although in some plants they are made by hand This work involves the risk of traumatic injuries which may become infected by the organic dust generally present in the air The better grades of mattresses are also sewn by hand and the workers are subject to wounds by the large needles used

The risks described in the making of new mattresses and upholstering new furniture are slight compared with those encountered during the renovation of old articles. Almost any infectious disease may be contracted by workmen who handle furniture especially bedding that has been used by infected persons. Smallpox has been contracted in this way in the past, and old mattresses are said to be a frequent means of spreading erysipelas scarlet fever diphtheria measles, and typhoid fever It follows that syphilis, tuberculosis, scabies, other parasitic infestations, and mycotic infections are also occupational hazards to which renovators are exposed.

In addition to the materials used for the actual stuffing of furniture upholsterers come in contact with irritating woods such as satinwood teak, and rungus (said to be noxious even when old and decaying) They also handle glue which contains ingredients capable of producing dermatitis. In some cases, especially in small shops, painting polishing, varnishing and lacquering may be part of the upholsterer's job (For details see the various subjects.)

The bad habit that upholsterers have of holding nails ready for use between their teeth has been responsible for some cases of occupational syphilis, although this is a rare occurrence

VARNISHERS AND VARNISH MAKERS

These workers may develop dermatitis from the resins, both natural and synthetic used in making the varnishes. The drying

oils rarely cause trouble but there occasionally occurs a case of sensitivity to such oils as linseed tung and fish which are used in varnishes

The principal cause of dermatitis, however among varnishers are the thinners These may be turpentine or petroleum distillates which act by defatting the skin causing chronic eczematoid dermatitis in most instances A few cases of acute vesicular dermatitis may occur from sudden severe exposures such as prolonged immersion of the hands in the thinner or some cases may be allergic to turpentine.

Prevention consists in wearing rubber gloves and impervious sleeves. If protective ointments are used they should be of the oil repellent type.

When varnishers remove old varnish with a solvent they should protect their hands and arms with rubber gloves and impervious sleeves.

WATERPROOFING

The water-resisting properties of rubber tar varnish lacquer and oil paints are well known. The substances themselves or their derivatives enter into numerous combinations for waterproofing various articles.

Paraffin for example is widely employed to coat or impregnate paper and cardboard. It is used to some extent also for leather Wood may be waterproofed by saturating it in hot paraffin oil or melted paraffin added to melted rosin. Crude anthracene also is used under the name of carbolineum as a paint to waterproof wood (See also Wood Preservatives, under Lumber and Woodworking Industries.) Contact with hot paraffin and its fumes may give rise to eczema, acne folliculitis, comedones and warts that have a tendency to become epitheliomata (See Petroleum) Contact with anthracene may cause a rash on the arms and hands. (See Anthracene.)

Umbrellas of varnished silk are treated with a paste composed of linseed oil boiled with 0 25 part litharge and 10 parts of dried and sifted pipeclay 3 parts of finely ground litharge and 1 part of lampblack After washing the silk copal varnish is applied Litharge lampblack varnish and solvents are potential irritants in this process

Another method of waterproofing is to use a solution of aluminum sulphate and rosin-soap The rosin is dissolved by boiling with sodium carbonate in water plus common salt the rosin-soap is then dissolved with soda-soap by boiling in 30 parts of water

Oil-cloth is made by dissolving rosin or lac by heating with linseed oil and coloring material and spreading the mixture on the cloth The rosin or lacquer solvents and the coloring materials used may produce irritation

Textiles may be rubberized by coating the fabric with a rubber solution by weaving in threads encased in rubber or by pressing

the cloth and thin rubber sheeting together between the rolls of a calender machine and thus forcing the substance into the fabric. As the rubber solution becomes heated the solvents, especially benzene, become vaporized and constitute a hazard both to the skin and systemically. (See Solvents.) Rain coats may be waterproofed with isinglass, alum and soap.

Canvas may be rendered impermeable by coating it with a mixture of gelatin and chrome alum and afterwards soaking it in a strong solution of chrome alum; also with a mixture of gelatin, alum and soda-soap dissolved in water. In the first process chrome is a source of danger while alum produces hardening and drying of the skin that leads to dermatitis.

Flax and hemp steeped in oak bark and boiling water absorb the tannin which renders them resistant to the action of water. Immersion of the skin in strong solutions of tannin causes hardening, blackening, and cracking often followed by painful sores.

Textiles may be boiled in a solution of soap, glue and water, after which they are wrung out, dried and placed in a solution of alum, salt and water. In this case the glue and the alum are possible irritants.

FIG. 115.—Shoe dresser dermatitis, due to dressings containing waxes, greases, dyes and solvents. (Case of Dr. John Godwin Downing.)

Other methods of waterproofing cloth are: (1) By passing it through machines that impregnate it with a warm solution of alum, next a warm solution of lead acetate, and then through fresh water. It is then brushed and beaten, hot pressed, and brushed again. As a result of these processes, lead sulphate is deposited in the fibers. Lead and alum are the hazards. (2) Coating the underside with a solution of isinglass and then applying an infusion of nut-galls. This method produces a kind of artificial leather. (3) Treating

with a solution of lead acetate, tannin, sodium sulphate, and alum. (4) For woolen cloth, powdered alum and lead acetate are dissolved in water. The clear liquid is poured off and isinglass dissolved in warm water is added. The garments are steeped in this solution for six hours, then drained and dried.

Paper, linen, and other tissues can be waterproofed by soaking in a solution of copper filings agitated in a closed vessel containing liquid ammonia. This causes the surface fibers to undergo an amalgamation that reduces their absorbent properties.

In the textile industry, many colors are mordanted or fixed upon the fabric to prevent their "running" when in contact with water. Potassium bichromate, chromium fluoride, and chrome alum are often used with acetic or formic acid for this purpose. Such mordants may cause irritation of the skin. (See Textiles.)

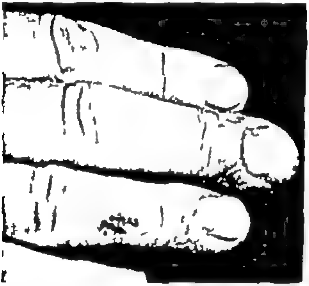

FIG. 146. Shoe trees, dermatitis, due to shoe dressings mixed with volatile solvents. (Case of Dr. John Godwin Downing.)

Leather can be made waterproof by the following methods: (1) Treatment with yellow soap, alum or aluminum sulphate boiled in water, dried by heat, and dissolved in turpentine. (2) A mixture of Burgundy pitch, yellow wax, ground-nut oil, iron sulphate, and essence of thyme. (3) Water, gelatin, and potassium bichromate. Practically all of these substances can be skin irritants.

Hats are made impermeable to water with linseed oil boiled with white lead, litharge, and umber. To impregnate the hat several coats of this preparation are applied, and finally the hat is varnished and pumiced. Another method is to apply shellac dissolved in ammonia water. Shellac used for this purpose generally contains a high percentage of benzene and is irritating to the skin as well as a constitutional danger. (See Solvents.)

Nitrocellulose dissolved in amyl acetate and acetone constitutes a hard protective varnish known as zapon brassoline crystalline Victoria varnish and so on. These preparations are used as a final coating for motor cars. Similar compounds are also used to impregnate linen for waterproofing purposes, and in the manufacture of artificial leathers. They cause dermatitis and are said to produce epilation.

Iron pipes may be protected against moisture by a coating of creosote oil linseed oil and rosin melted together at a high temperature or a similar preparation using coal tar and pitch instead of the creosote oil.

In waterproofing cement, lye, and alum are added to the cement mixture.

WELDERS

Welding is done either with the electric arc or with the oxyacetylene flame. Aside from metal fume fever welders and welders helpers, as well as workers in the immediate vicinity are subject to eye injuries from the brilliant flame burns of the body from flying sparks and accidental handling of hot metal and dermatitis from the actinic rays of the arc and from the irritant vapors and fumes coming off the metal or off the flux.

The electric arc gives off actinic rays and flash burns of the eye occur from them This manifests itself by conjunctivitis and episodes of temporary blindness. The welders themselves are not affected as frequently as their helpers, because the welders wear the helmet with the dark glasses, but the helpers do not Helpers often glance at the arc and they are usually not provided with dark glasses It is advisable to provide helpers with glasses not as dark as those worn by welders. The actinic rays will cause dermatitis similar to sunburn on exposed parts such as the chest and arms.

Alloys such as stainless steel may give off fumes of chromium compounds which may cause dermatitis and nasal mucitis

Fluxes used for welding may contain zinc chloride ammonium chloride and fluorides. The fluoride containing fluxes are used in welding aluminum alloys and stainless steel Flux fumes cause dermatitis and nasal mucitis.

When galvanized iron is welded the fumes coming off the operation contain zinc and tin salts which may cause dermatitis, mucitis and conjunctivitis.

Prevention.—Welders should wear properly designed welding helmets. They should wear coveralls with long sleeves closed at the neck and leather gloves. The coveralls should be flame proofed (Immersion in ammonium sulfamate solution) They should insert petroleum jelly into the nostrils at least twice daily In addition to these personal protective measures welding operations should be performed under proper exhaust conditions to remove injurious fumes and mists. Welders helpers should wear dark glasses flame proof coveralls, and leather gloves.

WINDOW SHADES AND VENETIAN BLINDS

The operations necessary for making shades and blinds are comparatively simple. In the first case cotton cloth is received from the mills already treated for the purpose with starch and some other substances whose exact nature is a trade secret. Shades are often painted with zinc and barium sulphate titanium oxide and chrome oxide colors some of the more expensive ones are decorated with hand painting Wooden rollers are bought ready made and the cloth is fixed to them with tacks. Cases of dermatitis reported from shade factories have usually been due to contact with the paint solvents notably benzine and benzol

Venetian blinds are made of slats of cedar bass, other wood and more rarely of metal These are cut at the factory to the proper size then sprayed with paint either by hand or in a mechanical apparatus. In some shops the slats are dipped by hand into a bath of paint For special blinds a coat of shellac is applied as a finish Holes are bored in the slats, cotton tapes adjusted and a pulley and cord affixed to the top of the blind Dermatitis may be caused by the various solvents used in painting and by their fumes especially in the process of hand-dipping which brings the workmen into close contact with the paint vats and frequently induces headache, vertigo and nausea Dermatitis has been noted in a Venetian blind maker due to manipulation of dyed cords and tapes. If the skin is damp contact with sawdust may provoke an eruption but as a rule the woodworking operations are carried out under hoods and dust is drawn off

WIRE DRAWERS

Wire drawers (see Metals) may develop dermatitis from the pickling solution of acid and alkali used on the wires to remove scale Also from the deposit of lime and other drawing compounds used on the wires Wire drawers should wear leather gloves or leather palm pads to protect them from the chemicals and from wire cuts. Picklers should wear protective clothing such as rubber gauntlets impervious aprons and rubber boots.

WOOD PRESERVING

All the chemicals used for this purpose are primary skin irritants and most of them are sensitizers. Dermatitis is of common occurrence among workers engaged in wood preserving The principal chemicals used for wood preserving are

- Heavy coal tar distillates like coal tar creosote
- Organic mercurial salts like phenyl mercuric compounds
- Chloro-phenol (tetra-penta) and their sodium salts
- Zinc chloride
- Potassium di-chromate
- Synthetic resins, chiefly of the phenol-formaldehyde and urea formaldehyde types, impregnated into wood and followed by curing

The prevention of dermatitis among workers handling the wood preservatives consists in daily change to clean work clothes frequent cleansing of soiled skin protective clothing in addition to enclosed processing methods. (See chapters on the above chemicals.)

WOOL

Diseases of the skin due to handling wool are well known. The most serious disease contracted by wool handlers is anthrax. Most of the anthrax cases seen by the authors have been caused by handling infected hides imported from Asia and a few cases from bristles in shaving brushes. R. Prosser White, however quotes Bridge to the effect that among 38 cases of anthrax, 15 were due to wool, 12 to hides and skins, and 8 to horsehair. Anthrax, however cannot be regarded merely as a skin disease even though the entrance is usually through the skin. The skin lesion is marked by the development of a pustule which may go on to an extensive necrosis and be surrounded by marked edema of the tissues accompanied with a severe toxemia. It is a septicemia and therefore the student is referred to other text-books dealing with the symptomatology of this disease. Wool and hides should first be disinfected to kill spores bacteria and fungi before being put through any manufacturing process.

Wool comes to the factory in bales which are opened on long tables and hand-sorted for quality. The hands and clothes of the wool sorters are usually covered with grease and dirt from the wool.

In a large wool factory where about 50 wool sorters were employed there were no cases of anthrax on record nor were there any cases of oil acne found among them. On examination of these workers, 2 cases of active epidermophytosis of the hands and 4 of the feet were found. The skin on the hands of the wool sorters was particularly soft and smooth probably due to being continuously covered with lanolin.

After the wool is sorted it is carried to the washing machines to be scoured. Among 4 workers on the scouring machines, 2 had an erythematous, vesicular oozing and crusting dermatitis of the hands and forearms. These men had their hands and forearms continually wet with the alkali solution used for scouring. This solution often contains soda ash and sodium silicate. The scourers are also in contact at times with such irritant solvents as naphtha and turpentine which are used to extract the fat from the wool.

After the wool is scoured and dried it is either spun directly into yarn which is then dyed or it is first dyed as "tops" and then spun into yarn. Two cases of dermatitis were seen in girls who themselves attributed it to handling black yarn which had been dyed with an acid black dye and chrome mordant. One man a "stripper" whose work consisted in taking the wool off the coating machines had a dermatitis which began shortly after he began this type of work and has continued ever since. It was an erythematous

papular vesicular rash on the dorsum of the hands. This rash improved during week-end holidays and sometimes disappeared when the man stayed away from work for longer periods, but always returned when he resumed his job He was extremely sensitive to wool Such sensitivity to wool and wool fat has been noted by other observers.

Scrotal and other skin cancers have been noted in England among cotton mule spinners and ascribed to mineral oil used to lubricate spinning spindles

There were about 100 workers employed on mule spinning machines in the factory investigated by the authors. No cases of carcinoma were seen among them. Only 1 case of small flat multiple papillomata of the hands was seen among these mule spinners. In this factory vegetable oils are used on the wool and although the mule spinners hands and aprons were saturated with mineral and vegetable oils, no cases of dermatitis were found amongst them

The majority of skin eruptions among the workers in the portion of the plant where the wool was manufactured was due to mycotic infection

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X-RAY WORKERS

X-rays are used not only in medicine but in industry They are used to detect flaws in metals and to detect imperfect citrus fruit The *x*-ray machines are usually well guarded to prevent ray leakage, nevertheless accidental leaking of *x*-rays may occur They may cause burns, atrophies pigmentation and cancer All *x*-ray workers should be examined periodically for blood changes and the machines examined at frequent intervals for leakage

CHAPTER XLVI

MEDICO-LEGAL ASPECTS OF OCCUPATIONAL DERMATITIS ✓

Workmen's compensation laws are designed for the purpose of reimbursing the worker for loss of earnings and cost of medical care resulting from occupational injuries or occupational diseases. This immediately brings up the question of a definition of an occupational disease.

Many definitions have been given and, as is the case with most definitions, objections can be made to all of them. Among those suggested are the following:

1. An occupational disease is one which occurs as a result of exposure to a recognized specific occupational hazard. It must have the accepted physical signs and symptoms of the specific disease caused by exposure to the specific occupational hazard.

This definition leaves no room for inclusion of newly discovered occupational diseases, nor for old ones with unusual or newly discovered symptoms and physical signs.

2. Occupational diseases are abnormal bodily or mental states directly resulting from exposure to harmful substances or conditions directly related to work (McCord).

This is a broader definition but still leaves open the question of harmful substances or conditions.

3. Occupational diseases are the outcome of long exposure to noxious influences during work occurring with particular frequency among workers in a specific industry.

This definition would leave out occupational diseases caused by short exposures to noxious influences, such as dermatitis caused by primary irritants, cyanosis which may be caused by short exposure to aniline, or caisson disease which may be caused by rapid decompression. Such diseases would have to be classed as occupational accidents, because of their sudden onsets. Compensation should be given for disease caused by the occupational environment rather than for diseases coming within the terms of the above definitions. For instance, if it can be proved that a worker contracted typhoid fever from drinking polluted water at his place of employment and nowhere else he should be entitled to compensation, regardless of the fact that typhoid fever is not classed as an occupational disease and regardless of whether his employer was or was not at fault in supplying such water.

State compensation laws are not uniform but can be grouped into three classes:

1. The schedule method in which only certain specially named diseases are compensated, with a description of the process in which

the disease must occur in order to be compensable. (Del Mich Minn. N J N Y N C Ohio Pa R. I Wash Ky Mass. Neb W Va.)

2 The general or blanket coverage method in which any and all occupational diseases are compensated without defining the term occupational disease. (Calif Mo N D Wis.)

3 The general coverage method with a statutory definition of the term occupational disease. (Conn Ill Ind)

Although occupational dermatitis is mentioned specifically in only a few of the State compensation laws nevertheless it can be included in most of the above classes and even in the compensation laws of those States in which only occupational accidents are compensated This is so because the hearings before compensation boards are informal the laws are broadly interpreted and the worker always gets the benefit of the doubt. Moreover compensation commissions are not only referees but investigators Since dermatological investigation is necessary to diagnose and determine the cause of dermatological conditions all compensation commissions should have available at least one impartial dermatologist who is specially versed in occupational skin diseases The duty of such a dermatologist would be to inform the commission in regard to the following (1) Do the working conditions present an actual occupational dermatitis hazard? (2) Has the worker an occupational dermatitis? (3) What is the actual cause of it? (4) Was it contracted at the place against which the claim is made? (5) Is or was the employee disabled by it? (6) Give an estimate of the time of disability (7) Express an opinion as to measures to be employed to prevent the recurrence of the condition (New occupation protective apparatus or clothes if worker returns to same occupation)

All dermatoses which affect workers are not necessarily of occupational origin therefore a worker claiming compensation for an allegedly occupational dermatitis must prove its occupational origin Here we must differentiate between a dermatitis directly caused by the worker s occupation and one which is caused not by the occupation but by the occupational environment For instance if a worker is exposed to a skin irritant in the course of his work and as a result contracts a dermatitis on the exposed parts, that dermatitis is directly occupational but if the worker contracts a dermatitis of his buttocks because he is sensitive to the paint or wood of the toilet seat which he uses at his place of work the dermatitis is caused by his occupational environment and not by his occupation

It is desirable to learn whether an occupational dermatitis is caused by a substance which will cause dermatitis on any one under similar working conditions or whether it is caused by a substance which will affect only certain workers who are sensitized to it In the first case, the substance is designated a *primary skin irritant* in the second a *sensitizer* A *primary cutaneous irritant* is an agent which will cause dermatitis by direct action on the normal skin at

the site of contact if it is permitted to act in sufficient intensity or quantity for a sufficient length of time. *A cutaneous sensitizer* is an agent which does not necessarily cause demonstrable cutaneous changes on first contact but may effect such changes in the skin that after five to seven days or more further contact on the same or other parts of the body will cause dermatitis.

The physician not versed in occupational processes and occupational skin hazards does not usually go to any great lengths in examining the occupational hazard or history of the patient before making a diagnosis of occupational dermatitis. This is especially so in states where the compensation laws do not require adequate diagnostic criteria and are so worded that if a physician undertakes to treat a worker and makes a diagnosis of occupational dermatitis his fee is guaranteed by the compensation commission or the insurance carrier. But if he makes a diagnosis of non-occupational dermatitis, he must look to the patient for his fee. This encourages diagnoses of occupational dermatitis.

There is no one factor on which a diagnosis of occupational dermatitis can be made. All of the following factors must be considered and properly evaluated.

1. **History.**—This must show that such a dermatitis was not present before the patient entered on his present occupation. It must show that the dermatitis developed during a period of occupational exposure or after a lapse of a reasonable incubation period following the cessation of exposure. This period should not be under a week. If the physician knows that other workers similarly employed are similarly affected, then the diagnosis of occupational dermatitis is more likely to be correct than if his patient is the only one of a group who is affected.

If the patient has previously had similar attacks when working with the same chemicals, the chances that he has an occupational dermatitis are increased. If the history shows that dermatitis occurs whenever the worker is at work, improves or disappears when he is away from work for a few days, and recurs soon after he returns to work, then there is established a definite cause and effect relationship between the occupation and the dermatitis.

2. **Site of the Eruption.**—The site of the eruption is important, because occupational dermatitis begins on the parts most exposed to the irritant: the fingers, hands, and forearms if the substance is handled; the face and neck where the industrial operation gives rise to dust, vapors, and fumes; and the covered parts of the body when the irritant penetrates the clothing. Especially is this so if work clothes and underclothes are not changed daily and if shower baths are not taken before leaving the work place. Portions of the body subject to friction are often sites of occupational dermatitis: the wrist, the belt line, the ankle at the shoe top, the neck at the collar line—all are sites where irritants may be rubbed into the skin. Sometimes an irritant not strong enough to cause dermatitis on the fingers may be carried by the hands to the tender skin under the

eyes and cause dermatitis there. Sometimes an occupational dermatitis may become generalized. Especially does this occur in workers who have a high degree of sensitivity and who are entirely exposed to irritant penetrating dusts, fumes, or vapors, or who work for long periods without changing work clothes.

3 **Appearance of Lesions.**—This is not characteristic except in a few classes of occupational irritants. Paronychia and onycholysis are common occupational lesions among fruit and vegetable canners, dish washers, soda fountain attendants, scrub-women, and housewives. Acne-like lesions, folliculitis, and boils on the arms and legs are characteristic occupational lesions among workers exposed to cutting oils crude petroleum heavy coal tar distillates, and certain viscous and wax-like chlorinated hydrocarbons. Hydroscopic chemicals, such as sugar salt, and lime and the volatile solvents, will in time cause the skin to become defatted and fissured.

4 **Differential Diagnosis.**—The common non-occupational diseases of the skin such as seborrheic dermatitis, pityriasis rosea, erythema multiforme neurodermatitis, fungus infections and their allergic manifestations, and contact dermatitis caused by irritants encountered outside of the work shop must be differentiated from occupational dermatitis. It is true that the presence of these diseases does not exclude the presence of an occupational dermatitis. In fact an occupational dermatitis may more easily occur on a skin which is already damaged by another skin disease.

The fungus infections and their allergic manifestations, the so-called phytids, cause the most controversies before compensation boards. The defendants often contend that the skin disease for which the worker claims compensation is not occupational but is of fungus origin. Especially is this the defense when the worker is found to have a definite fungus infection of the feet, groin or other parts of the body not exposed to the occupational irritant. In these cases the defendant claims that the skin lesions on the exposed parts are also fungus infections or the result of allergic manifestations to the fungus infections (dermatophytids). The various tests with trichophytin are of little value in making a differential diagnosis because they are nearly always positive as most persons have had these infections. They are of value only in the rare cases in which the tests are negative because then they tend to show that the claimant has had no fungus infection. But even if it is shown that the claimant has an active fungus infection or phytid this does not rule out the possibility that he may also have an occupational dermatitis. In fact it is held by some authorities that an allergy to fungus infections predisposes to allergic occupational dermatitis. We cannot subscribe to this theory. Although we agree that a skin damaged by the lesions of a fungus infection is more easily irritated by an external irritant than the normal skin, and may even grant that such a damaged skin may be more easily entered and sensitized by a sensitizing substance. We cannot conceive that sensitivity to a specific substance predisposes to sensitivity to an entirely different substance. If this

were so our accepted theories of specific sensitivities and specific immunities on which rests much of our therapy would have to be entirely revised. Those of us who are allergic to some substance, and many of us are, would all tend to become allergic to many substances and those of us immunized to one disease such as typhoid or smallpox, would tend to become immune to all diseases. The facts are exactly the opposite. Most of us do not take on new allergies, but tend to lose the ones we have. Children affected with the so-called atopic eczemas tend to lose them as they grow older. Grown ups sensitive to ragweed do not as a rule become sensitive to other plants. Those immunized against smallpox must also be immunized separately against typhoid, yellow fever, typhus fever, plague, or whatever other disease they are to be protected against.

It is also difficult to differentiate occupational from non-occupational contact dermatitis. The lesions and sites are similar and only a careful elicitation and consideration of all the facts can lead to a correct understanding of the cause. In these cases and in differentiating fungus infections, the patch test is of great value.

The patch test is based on the theory that if a dermatitis is caused by hypersensitivity to a certain substance, such substance when applied to an area of unaffected skin of the susceptible individual and left on for a period of time will cause an inflammation at the spot where it touches the skin. In doing patch tests, it is important to know what concentrations of certain chemicals can come in contact with the normal skin for a stated period of time without causing an inflammation or reaction. It is also important that no primary irritants such as strong acids or alkalis, be used in the patch test, as they will burn any skin. The portion of the body on which a patch test is to be performed is also of importance because it has been found that the different portions may vary in sensitivity to certain chemicals. For instance, the tough horny skin on the hand is less susceptible to irritants than the more tender skin on the inner surface of the forearm. For this reason patch tests performed on uninflamed skin adjacent to the eruption are more likely to give reactions of diagnostic significance than when performed on more distant areas.

If the worker is handling known irritants and his fellow workers are also affected, the cause is obvious and the patch test is unnecessary, but if he is the only one of the group who is affected, then he should be tested with the materials with which he comes in contact in the course of his occupation. If he is patch tested with only one substance, a control patch should be also used. If the subject is tested with more than one substance any negative reaction from one of these substances serves as a control. It is also desirable to use as a control one of the workers who has no dermatitis.

In patching with solids, best results are obtained by moistening them, preferably with perspiration obtained from the armpit of the patient. Sometimes it may be necessary in order to obtain a

reaction from a patch test to use perspirations of differing hydrogen ion concentrations. The results of patch tests must be correlated with the worker's particular occupation, the history of the dermatitis and the site and morphology of the lesion in order to arrive at a correct etiologic diagnosis.

Patch tests are only a link in the chain of evidence on which a diagnosis of industrial dermatitis is made. A positive reaction shows only that the portion of the skin on which the patch was applied was at that time sensitive to the particular substance. In order to state that this substance was the cause of the occupational dermatitis we must be sure that the patient was exposed to the substance in the course of his work and presuppose that the patient's skin was also sensitive at the time of industrial exposure.

When negative results are obtained from patch tests with the materials met with in the course of the patient's occupation, we must not conclude too hastily that the dermatitis is not of industrial origin, for one or more of the following reasons:

1. The skin area over which the patch was placed may not be hypersensitive, whereas the area covered by the eruption may be hypersensitive.

2. If the eruption has disappeared the patient may no longer be sensitive when the patch test is performed but may have been sensitive at the time he had the eruption and when he was industrially exposed.

3. A negative reaction may be due to the fact that the patch test never accurately reproduces actual working conditions, such as friction, maceration, heat, cold and sunlight, which may be additional factors adding to the irritating effect of the substance to which the patient is exposed.

4. It may be that the concentration and amount of the chemicals applied as a patch test may not be as great as they actually were during industrial exposure.

5. Finally, the actual industrial irritant may not have been discovered and applied as a patch test.

When negative reactions are obtained from patch tests with substances encountered in the work room and the dermatitis which the worker has resembles a contact dermatitis, an effort must be made to perform patch tests with materials met with in the patient's home, which may be the cause of dermatitis. Certain plants or perhaps paints or even new furniture are examples of such materials. Tests of this kind will in some cases show that the patient is sensitive to materials met with outside of industry and is not sensitive to the materials with which he comes in contact in his place of employment.

The technique of performing patch tests is important. When testing for hypersensitivity to primary irritants, such dilutions must be used in the tests as are known not to irritate the normal skin.

The ordinary procedure in performing a patch test is as follows: A sample of the material to be tested is first placed on a suitable skin site—the inner surface of the arm or forearm, or the back

usually being chosen. If the material to be tested is a solid it may be used as such, or a piece of gauze about four ply thick and a quarter to a half inch square may be moistened with water or perspiration and impregnated with the material. In the case of liquids or solutions of the substance to be tested, the gauze square is dipped in the fluid and applied to the skin. Again it is emphasized that only those materials or proper dilutions of substances in solution should be used that are known not to affect the normal skin. Over the patch test substance, or the gauze patch impregnated with this substance, is placed a piece of insulating material about an inch square, and a two inch square of adhesive is placed over all to hold the patch in place. The insulating material inserted between the chemical and the adhesive plaster should be a non-irritant substance, such as unvarnished cellulose or, better still, a thin sheet of mica may be used. The resin on waterproof cellophane itself may be an irritant as may be some of the compounds in dental rubber. The adhesive plaster used to hold the patch in place often causes an erythema of the skin. The patch test is allowed to remain on the skin for twenty-four to forty-eight hours before removal and the site is observed for several days thereafter for determination of the result.

Patch tests are considered negative (—) when no reaction occurs at the site in contact with the substance being tested. A transient erythema that does not persist at least twenty-four hours is also considered negative. Positive patch tests are usually graded from one plus (1 +) to four plus (4 +) depending on the severity of the reaction.

At the time the patches are removed there may be no reaction present, but some time later, a few hours to a few days, a delayed reaction may develop at the site of the patch. We should regard delayed reactions as denoting a lesser degree of hypersensitivity than undelayed reactions provided the concentration and amount of the patch testing substance is the same and the area covered by the patch is the same.

Patch tests properly performed and evaluated can be of great help in the diagnosis of industrial dermatitis, but if improperly performed and evaluated, they may lead to confusing and unjust conclusions.

Allergy as a Cause of Occupational Dermatitis.—Allergy is a word to denote an altered reactivity in human beings or in animals caused by a first contact with a substance and manifested after an interval of time (period of incubation) upon second contact with the original or identical substance. A standard medical dictionary, however, defines it as "A condition of unusual or exaggerated specific susceptibility to a substance which is harmless in similar amounts for the majority of members of the same species." This definition differs radically from the first by the fact that it does not presuppose that sensitization is caused by the first contact and that it develops

only after a period of incubation has elapsed and only after another contact has occurred

The allergy as defined by the dictionary may be caused by a visible or demonstrable breach in the defense mechanism of the skin such as abrasions disease of the skin thinning of the epithelium loss of the normal fluids of the skin etc. which enable an irritant to enter it easily But the conception of the first definition implies that changes caused by the first contact so condition the skin even though no change is demonstrable that after a period of incubation has elapsed second contact with the substance causes a dermatitis. If the first definition is to be accepted then allergy causes less than 20 per cent of all occupational dermatitis.

Allergy should not be a bar to compensation for occupational dermatitis. Allergic occupational dermatitis usually develops in new workers about five days to three weeks after beginning work. In most cases if the worker is able to keep on working the dermatitis clears up—the worker becomes "hardened" Only a small percentage of such cases do not develop this "hardening" The worker should be removed from the job if the dermatitis does not clear up after two months of treatment or if he develops recurrent attacks of dermatitis while working

A chronic dermatitis more or less generalized occasionally occurs in a worker usually past middle age the cause of which it is almost impossible to determine. Such a worker's history shows that he has worked at the same occupation for many years without any trouble and then suddenly develops a dermatitis which persists even though he stops working for a long time. An examination of his work may reveal no new chemicals or changes in process to which the dermatitis can be attributed The claim is made that the worker has become sensitized to some substance or substances in his work and that as a result of that sensitization he has become sensitized to many other substances which are not connected with his work. Therefore, he cannot get well even though he leaves his job There are many dermatologists and allergists who will support such a contention. But they cannot prove that the patient did not first develop a sensitivity to a substance met outside the working environment, and that the occupational sensitivity did not follow and was not secondary to the non-occupational one

Patch tests on such persons are unsatisfactory and sometimes impractical because the patient may be feeble and the risk of a flare-up of the skin lesions cannot be taken or there may be no normal areas of skin on which a patch test could be performed. Such a damaged skin may react to anything in the form of a patch test. If such patch tests are performed and results are positive, it may be concluded that his occupation is at least a contributing factor to the dermatitis Even if the patch test shows negative reactions to the substances in his working environment and positive reactions to non-occupational ones, it still can be argued that this is only presumptive and not positive proof that he was not sensitive

to those substances in his occupational environment at the time that he first became sensitized This would imply that the worker originally developed a dermatitis as a result of becoming sensitized to some substance encountered in his occupation. Following this he developed a polysensitivity—that is, he also became hypersensitive to substances encountered elsewhere than in his occupational environment. Subsequently and prior to the time of patch testing he lost his original hypersensitivity to substances encountered at his occupation but retained his hypersensitivity to the substances encountered away from his occupational environment. This contention should not be supported If it is, then every allergic condition in a worker which first manifests itself after he begins to work can be reasoned to be of occupational origin. Besides, such a theory is contrary to the accepted theories of specific sensitivities and specific immunities. In fact, it is usual for new workers handling sensitizing chemicals to develop an allergic dermatitis five days to three weeks after beginning work, and for the large majority of them to get well become "hardened" as the workers call it, and work without further trouble they become desensitized instead of polysensitive.

But even if we should admit that one sensitivity predisposes to another and finally to polysensitivity it would still remain debatable whether polysensitivity causing a chronic persistent allergic dermatitis in a worker is the result of an occupational sensitivity first acquired to which the non-occupational sensitivities are secondary or *vice versa*.

Polyvalent sensitivities causing allergic generalized eczemas also occur among people exposed non-occupationally to sensitizers. Their causes are many and often undetermined. It is true that if such a worker shows a positive reaction to a patch test with any of the substances which he encounters in the course of his work, his occupation should be considered to be at least a contributory cause of his dermatitis but if the patch tests with these substances are negative, or are not performed then the occupational etiology of his dermatitis has not been established and is open to question.

Claims have been made before compensation commissions that the ordinary skin diseases of unknown etiology such as psoriasis and lichen planus, are caused by the worker's occupation. The physician on the witness stand is often asked "Well Doctor since the causes of this disease are not known is it not possible that the plaintiff's occupation was the cause of it? Answer yes or no The physician should answer "No, and then explain that if the plaintiff's occupation were one of the causes of the disease then a large percentage of the workers employed at it would also be affected which of course is not so.

It is possible that new lesions of psoriasis and lichen planus may appear on areas of skin which have been injured in the course of work, as is the case in injury from any cause, but the psoriatic tendency was present before the trauma. So, although new lesions

which occur on areas of the skin occupationally traumatized may be said to be occupational this cannot be said of the disease entity itself

Occupational Cancer—It is generally recognized that tar soot pitch crude petroleum the actinic solar rays roentgen-rays, and radium have carcinogenic properties. Workers with these substances who develop carcinoma can claim that it was caused by occupational exposure but it must be remembered that the normal incidence of cancer among human beings must also be taken into account. Occupational skin cancers have certain characteristics

They always appear on parts exposed to the carcinogenic agent.

They are often multiple and recurrent.

They are always preceded by a precancerous lesion.

They always appear in workers who have long been exposed to the carcinogen

They usually do not have metastases.

For instance if a worker develops a cancer on the face and it is shown that in his occupation he is exposed to the fumes of coal tar pitch it is likely that the cancer is an occupational one. But if a similar worker develops a cancer of the lower lip and it is shown that he is a pipe smoker the occupational origin of his tumor is, to say the least, questionable.

Workers exposed to alpha and betanaphthylamine and benzidine in synthetic-dye plants who develop tumors of the bladder have a legitimate claim for the occupational origin of the tumors. Workers in radium mining who develop carcinoma of the lungs can also rightly claim occupational origin Physicians and laboratory technicians who work with roentgen-ray or radium and develop carcinomata of the hands have a legitimate claim of occupational cancer Radium can also cause cancer of the bones, especially if it is ingested But the actinic-ray cancers on the exposed parts of workers in sunny tropical climes are not so clearly of occupational origin because they live in that climate and are still exposed to the actinic rays when they are not at work

The rôle of arsenic as a cause of occupational cancer is open to debate. There is no doubt that the long-continued oral ingestion of inorganic arsenic can cause palmar and plantar keratoses. But to claim that the cancer appearing on the face or hands of a farmer is due to the arsenical insecticides which he may use is rather far fetched especially when the farmer is also exposed to actinic rays. Examination, by the authors, of many hundreds of workers with arsenical insecticides and other arsenic compounds has failed to show any skin cancers. The medical records of the factories in which these persons were employed also failed to show skin cancers. Reports of State compensation boards received by the authors for the past ten years fail to show any skin cancers attributed to arsenic although there are many reported as caused by coal tar and petroleum

The reports of cases of occupational arsenical cancers by certain

authors are open to the criticism that the etiology of the cancers was not proved but inferred. The proof usually consisted of the fact that the worker said he handled arsenic or he was a miner of ore which may have contained arsenic. Post hoc ergo propter hoc. This is poor evidence.

Trauma as a Cause of Cancer.—Cancer when it occurs is often attributed to faintly-remembered blows. However, blows are of common occurrence, whereas cancer at the site of trauma is extremely rare. Therefore the burden of proof of trauma causing cancer is on the claimant. He must first show that the part was normal before the trauma; that the blow was a severe one, or very often repeated, and included the site of the tumor; that a sufficient interval elapsed between the occurrence of the injury and the appearance of the tumor; that a biopsy verifies the carcinomatous nature of the tumor.

Chronic occupational irritation may be a cause of cancer.

Cancers arising in scars resulting from occupational injuries can certainly be called occupational.

The Physician and the Compensation Commission.—Every physician making a diagnosis of occupational dermatitis should fill out the following questionnaire in reporting his case.

SKIN CLINIC

Date

Name ___ Age Race

Type of Skin (Dry, Moist) (Thick, Thin) (P[illegible]-like) (Dark, Light, Freckled) Chapped

Previous Skin Diseases

___

History of Allergy (hay fever, asthma, plant poisoning, etc.)

___

Name of Employer

Manufactures [illegible]

Briefly Describe Work ___

Present Work B[illegible] Present Disease Began

C[illegible]

Describe Lesion

PATCH TESTS PERFORMED

Substances	Concentrations	Time	Reaction

Dermatitis Caused By ____

Diagnosis Based On ____

Treatment Given ____

Preventives Advised ____

Advised Change Work ____ How Long ____

Remarks ____

The answers to these questions will enable the commission to judge the criteria on which the diagnosis is made.

If the physician is to appear before the commission he should make himself thoroughly familiar with the occupational process at which the patient works the health hazards involved the occupational history of the patient, and the literature concerning the hazards of the patient's occupation. He should be familiar with all the diagnostic tests involved and should be prepared for a rigid cross examination.

The expert physician should confer with the lawyer before the trial and coach him as to what questions to ask on direct examination to best bring out the evidence in favor of his client. He should also instruct the lawyer on weak points in the case of the opposition so that he can cross examine to the best advantage the expert physician on the other side of the case.

The physician on the witness stand should answer the question as put (if his counsel does not object) but if an explanation is necessary he may give it after answering the question. He should never hesitate to say I don't know when he does not know It

makes what he does say much stronger, and may keep him out of trouble.

For instance, a certain well known dermatologist testifying before the Federal Trade Commission in the case of a progressive lead hair dye which was advertised as stimulating the natural pigment forming cells of the scalp testified that the preparation was a dye. He was asked on cross examination "Would it dye cotton?" After hesitating he answered "Yes." Whereupon the lawyer placed some cotton in the colorless liquid hair dye, allowed it to stay in for a while, then pulled it out to show that it was not dyed. The physician was chagrined, and the incident tended to belittle the physician's qualifications as an expert. He should have answered "I do not know. I never tried to dye cotton with it." Fortunately the author was present and knew that lead salts could be made to dye cotton if the cotton was first treated with a sulphur compound so that it contained sulphur, as does the hair. He asked the lawyer (for the Government) to put him on the stand and ask the same question, to which the same answer was given, and a piece of white gauze was first dipped into a solution of sodium thiosulphate, allowed to dry, then immersed in the colorless lead hair dye solution. After a few minutes, when lead sulphide was formed on the gauze, it was seen to turn dark.

The physician should also confer with counsel so that he may know how to bring out facts showing that the medical qualifications, experience, ethics and standing of an unscrupulous expert are not of the best.

Dermatitis From Wearing Apparel and Cosmetics.—Dermatitis allegedly caused by wearing apparel, cosmetics, and jewelry is frequently reported, but when we consider that the entire population is constantly exposed to them, we realize that the percentage of the population affected is almost negligible.

The records of the casualty insurance carriers for 1941 show that only 78 claims for dermatitis from wearing apparel and cosmetics were reported to them. The table classifies these cases according to cause.

Wearing Apparel		*Cosmetics*	
Hat bands	13	Hair preparations	16
Pajamas	9	Soaps	6
Underwear, women	6	Face creams	6
Hose, women	5	Nail polish	2
Dresses, women	3	Mascara	1
Shorts, men	4	Face powder	1
Wrist watch straps	3	Deodorant	1
Clothes, men	2	Hand lotion	1
Dress shields	1		
Total	47	Total	31

The National Retail Dry Goods Association sent a questionnaire to its members asking the number of claims they had for dermatitis from January 1, 1940 to July 1, 1941. Fifty stores reported that

they had no complaints 60 stores reported 656 cases, classified as follows

Wearing apparel, women	425
Wearing apparel, men	61
Cosmetics	61
Miscellaneous	9
Not accounted for	100
Total	656

One hundred and thirty-three stores reported that they had complaints but did not give the number of them nor the year in which they were made. They were classified as follows

Number of stores reporting complaints from wearing apparel and cosmetics—

From dresses	14	From pajamas	5
From rayon	13	From jewelry	4
From furs	11	From underwear women	3
From corsets	10	From garters	3
From hosiery	10	From miscellaneous	21
From wool	9	From cosmetics	10
From underwear men	8		
From coats		Total	133
From cotton	5		

The stores reporting to the National Retail Drygoods Association reported only 17 of these cases to the insurance carriers so that there is but little duplication in all of these figures Therefore it is safe to say that there are less than 1,000 cases of dermatitis per year allegedly caused by wearing apparel and cosmetics among 130 million people This is one case per 130,000 and even less, for when we examine the reports we find that only a small percentage of the claims were proved if judged by accepted medical criteria.

Only a few of these cases went to trial Most of them were either dropped or were settled by crediting the merchandise by paying the medical bills, by small cash settlements or by combinations of these.

Allergenic substances are the principal causes of dermatitis from wearing apparel and there will always be some people who are allergic to substances which are harmless to by far the large majority

Hair wave preparations hair dyes medicated soaps skin creams and nail polish are the principal cosmetics reported as causes of dermatitis. The hair wave preparations are strongly alkaline and are classed as primary irritants but the hair dyes soaps, creams, and nail polish are only sensitizers.

In looking over the claims we note that the products complained of were made by a few manufacturers For instance all the hat band complaints were against one large hat manufacturer The wrist watch strap complaints were all against one product. The large majority of the hosiery and pajama complaints could be traced to one finish Most of the hair preparation complaints were against two or three cosmetic trade names and all the nail-polish complaints were against one maker of nail polish Therefore it must be presumed that the manufacturers used some unusual or new chemicals

in their products, or that they were careless in their manufacturing processes. Furthermore it must be presumed that they did not perform approved toxicity tests on the products before selling them to the public.

It seems likely that if the plaintiffs in these cases had known that many others were being affected by the same products they could have made a strong case against the manufacturers.

Except for the occasional outbreaks of dermatitis from new and untested products, the majority of the claims for dermatitis from wearing apparel and cosmetics are either due to the constitutional idiosyncrasy of the plaintiff or they are false

It is not difficult to determine the cause of a dermatitis due to wearing apparel or cosmetics. Such an eruption begins at the site of contact with the irritant, usually five days or more after the first contact, provided there is at least a second contact at the lapse of this period, or if the contact has been continuous or intermittent. This is the period of incubation for the establishment of sensitivity The eruption may occur sooner if the article of wear or the cosmetic contains a primary skin irritant, or if the patient has previously been sensitive to the sensitizer in the garment or the cosmetic.

The eruption is usually confined to the sites touched by the irritant. Only in exceptional cases is there a generalized eruption The eruption disappears or improves when the offending garment or the cosmetic is not used and becomes worse or returns every time it is again used.

It is possible to find the actual chemical in the garment or cosmetic which is the cause of the dermatitis. Methods for determining this have been devised It may be a long and difficult process in an individual case and not of sufficient importance to warrant spending the time but every physician making a diagnosis of dermatitis from a fabric or cosmetic in the case of a patient who intends to claim damages should be at least required to fill out the following form If he does this properly he will make a favorable impression on the witness stand and escape much embarrassment on cross examination.

1 When did patient buy the garment or cosmetic?
2. From what firm?
3 Date when it was first worn or used
4. Date when eruption was first noticed.
5. What parts of body were first affected?
6. Give order in which eruption spread.
7 Describe entire extent of eruption
8. What previous skin diseases did the patient have?
9 Has the patient a *history of skin or mucous membrane allergy?*
10. What drugs, if any does the patient use?
11 What laxatives
12 What sedatives
13. Were any drugs taken before present eruption?
14 Was poison ivy or other irritant plants contacted before eruption?
15 Is the eruption still present
16 When was use of garment or cosmetic discontinued?

17. How long after this did the eruption persist?
18. Were patch tests performed?
19. If so, with what substances? Describe tests in detail and give results.
20. If no patch tests were done, give reasons for not doing them.
21. Has the actual chemical causing the dermatitis been found?
22. Describe how this was accomplished.
23. Summarize the facts on which you base your diagnosis.
24. What treatment was given?
25. Give prognosis.

Before testifying in court the expert must make himself thoroughly familiar with all the aspects of the case and with the medical literature pertaining to such cases. The counsel and the expert dermatologist, before appearing in court on claim cases, should discuss the merits of the case so that they can agree on the questions which on direct examination will best bring out the facts to prove their claims and to refute the claims of their opponents.

Some Points the Plaintiff Should Try to Show

1. That there were many other users similarly affected.
2. That the material causing the dermatitis was made with chemicals which are notorious sensitizers.
3. That the materials causing the dermatitis contained new chemicals or chemicals not previously used in such materials.
4. That the manufacturer did not properly ascertain the skin irritating properties of the product before offering it for sale.
5. That the particular garment was not properly processed according to the accepted custom of the trade, *i. e.*, "dirty fur" finish not properly applied, dye bled, etc.
6. Patch tests properly performed on patient and controls show that garment or cosmetic is a primary irritant or sensitizer, and was the cause of the dermatitis.
7. That the patient was not sensitive before the substance was used.
8. That using the substance was the cause of the sensitization.
9. That using the material caused the eruption to appear or get worse and *vice versa*.
10. That the plaintiff was not allergic to any other substance which may have caused the dermatitis.

Some Points the Defendant Should Try to Show

1. That although there were thousands of users of similar substances, the plaintiff was the only one affected.
2. That the substance contained no primary irritants nor strong sensitizers.
3. That the substance contained no new chemicals or chemicals not previously used in such materials.
4. That the substance was made in the usual manner in which such substances are made and approved by the trade.
5. That the new chemicals used, if any, were properly tested by recognized authorities and found to be no more irritating than chemicals commonly used for the same purpose.
6. That the finished product was properly tested by recognized authorities on a sufficient number of people and found to be no more harmful than other similar substances before it was placed on sale.
7. That the particular garment or cosmetic used by the plaintiff did not differ from all the others which had been sold and which caused no trouble.

8. That the dermatitis of the claimant did not have a cause and effect relation with using the substance, i. e., that it did not begin where the substance touched the skin, that it appeared, disappeared, got worse, improved, regardless of whether the substance was or was not used.
9. That the patch tests were negative, or if positive, were not properly performed or evaluated, i. e., patch tests made with extract of substance permitted to remain on too long, patch tests were more severe than actual use, no control patches nor control persons were used.
10. That the disease was not a contact dermatitis, but something else.
11. That the plaintiff is allergic to other substances which may have caused the dermatitis.

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CHAPTER XLVII

CHEMICALS WHICH ARE KNOWN TO BE SKIN IRRITANTS

(List taken from Chemical Industries, November 1944 Vol. 55 No 6).

ACETAL.—$CH_3CH(OC_2H_5)_2$. M W 118.11 Colorless liq., agreeable odor Sp gr 0.831 B P 102.2 C Sol. water alcohol, ether Uses general solvent

ACETALDEHYDE.—CH_3CHO M W 44.03 Colorless, inflam liq pungent, fruity odor Sp gr 0 782 (15 C) M P −123.5 C B.P 20.2° C Sol. water alcohol, ether Uses mfr organic derivatives, paraldehyde synth drugs, dyestuffs, yeast albumin in silvering mirrors as photographic developer in phenolic resins mfr synth rubber

ACETIC ANHYDRIDE (Acetic Oxide, Acetyl Oxide) —$(CH_3CO)_2O$ M W 102.05 Colorless liq strong acetic odor Sp gr 1.082 (15 C) B.P 139 6 C Sol. alcohol, chloroform, ether Decomposes with water to acetic acid Uses mfr alkyl acetates, fine chemicals, intermediates, synthetic drugs, synthetic dyes, airplane dopes and varnishes, non-inflammable motion picture films, cellulose acetate acetate rayon in medicine.

ACETONE (Dimethylketal, Dimethylketone, Ketopropane, Proacetic, Ether Methylacetyl, Propanone) —$CH_3.COCH_3$. Colorless, inflam. liq fragrant, mint-like odor Sp. gr 0 799 (25 C) M P 94 0 C B P 55.5 −57.5 C Miscible water alcohol, ether ethereal salts, many oils.

ACETONITRILE (Ethanenitrile, Methyl Cyanide) —CH_3CN M W 41 03 Colorless liquid M.P −41 to −44 C B P 82

ACETONYL ACETONE —$CH_3(CO)CH_2CH_2(CO)CH_3$. A colorless, water-sol. liq B P 191.3 C Solvent for cellulose acetate, with a xylene nitrocellulose dilution ratio of 1.8. A small per cent reduces the viscosity of nitrocellulose and vinylite resin solutions. Has tanning effect on hides and skins.

ACETYL CHLORIDE (Ethanoyl Chloride) —CH_3COCl M W 78 48. Colorless, burning liq, strong odor, irritates the eyes. Sp gr 1 1051 (20 C) M P 112 C B.P 52 C Sol ether miscible with acetone acetic acid reacts violently with alcohol and water Uses mfr acetyl derivatives, intermediates, pharmaceuticals, synth dyes

ACETYL METHYL CARBINOL (Acetoin) —CH_3—CO—CHOH—CH_3. Slightly yellow liq with tendency to slowly change to cry polymer which can be converted back into monomer by careful melting of crystals. Sp gr 1.016 (15 C) B P 140 C 144 C Miscible with water in all proportions. In contact with air slowly oxidizes to diacetyl Uses in place of diacetyl in cases where diacetyl itself is too volatile

ACETYLENE TETRACHLORIDE (Acetosol, Boroform, Cellon, Tetrachloroethane) —$CHCl_2CHCl_2$ M W 167.85. Colorless liq Sp gr 1 000 (20 /4° C) Pounds/gal 13.19 M.P 43.8 C B P 146.3 C Sol alcohol ether Insol water Uses mfr intermediates, organic chemicals, paint and varnish removers, acetate varnishes, photographic films denaturing alcohol solvent for shellac, gum, camphor, sulphur phosphorus, the halogens, oils, cellulose acetate resins degreasing metals prior to electroplating in enameling in insecticides.

ACID ACETIC (Vinegar Acid, Ethanoic Acid, Methanecarboxylic Acid) — CH_3COOH Colorless liq. of pungent odor Sp. gr. 1.049 (25 C.) M.P. 16.7 C. B.P. 118.1 C. Sol. water alcohol and ether. Uses: mfr. metallic acetates, acetyl organic derivatives, intermediates, esters, pharmaceuticals, azo dyes, methyl violet, matches, printing inks, artificial leather, aeroplane lacquers, white lead, copper pigments, varnishes, polishes, moving picture films, cellulose acetates, phenol-formaldehyde resins, rayon, printing pastes as curing agent, insecticide ingredient, in coagulating rubber latex, assist in dyeing wool and silk, in engraving, as resin solvent, electroplating reagent, in medicine.

ACID ARSENIC (Arsenic Pentoxide, Orthoarsenic Acid) — $H_3AsO_4.\frac{1}{2}H_2O$ Colorless cryst. Sp. gr. 2–2.5 C. M.P. 35.5 C. B.P. 160 C. Sol. water. Slightly sol. alcohol. Uses: mfr. arsenates, insecticidal compositions, glass, assist in dyeing and calico printing. Very poisonous.

ACID CARBOLIC CRYSTALS (Phenol) — C_6H_5OH M.W. 94.05 White cryst., distinctive odor. Sp. gr. 1.071–2 M.P. 42.5–43 C. B.P. 182.6° C. Sol. water alcohol chloroform ether glycerine alkalies. Uses: mfr. deodorizing preparations, germicide soaps, synth. perfumes, as disinfectant, antiseptic, germicide. Very poisonous.

ACID CHLOROACETIC, Di (Dichloroacetic Acid, Carboxy Methyl Chloride) — $CHCl_2COOH$ M.W. 128.93 Colorless liq., pungent odor. Sp. gr. 1.560 (25 C.) B.P. 194 C. M.P. 10 —4 C. Uses: in organic synthesis, in medicine.

ACID CHLOROACETIC, Mono.—$CH_2Cl\,COOH$ M.W. 94.48 Deliq. color less cryst. Sp. gr. 1.400 (62 C.) M.P. 61.2 C. B.P. 189.5 C. Uses: mfr. intermediates, dyes, in organic synthesis, in medicine. Caution: handle carefully.

ACID CHLOROACETIC, Tri.—Cl_3CCOOH Deliq. cryst., suffocating odor. Sp. gr. 1.6298. M.P. 57 C. B.P. 195 C. Sol. water alcohol, ether. Uses: mfr. intermediates, organic chemicals, as laboratory reagents, in medicine.

ACID CHLOROSULFONIC (Sulphuric Chlorohydrin) — SO_2ClOH M.W. 116.52. Brown oily corrosive, fuming liq. Sp. gr. 1.784 B.P. 151.5 C. Sol. water alcohol. Uses: mfr. intermediates, rosaniline, alizarin, purpurine, organic chemicals, synthetic drugs, saccharine, military poison gas.

ACID CHROMIC (Chromic Anhydride, Chromium Trioxide) CrO_3 Reddish-brown deliq. cryst. Sp. gr. 2.67–2.82. M.P. 196 C. Sol. water ether. Uses: mfr. chromates, chrome dyestuffs, electric batteries, colored glass, printing and lithographic inks, a mordant in dyeing and printing textiles, laboratory reagent, oxidizing agent, in chrome plating process, engraving, anodizing aluminum, medicine.

ACID CRESYLIC Mixture of Ortho, Meta and Para Cresol (Cresyl, Paracresylol, Methyl Phenol) $CH_3C_6H_4OH$ Straw to brown-red colored liq., phenolic odor. Sp. gr. 1.018–1.045 M.P. 80 C. B.P. 185–230 C. Sol. water, ammonia, glycerine, caustic soda, petroleum spirit. Uses: mfr. cresols, disinfectants, sheep dips, flotation, synthetic resin, in medicine, gasoline gum inhibitor, manufacture lubricating oils.

ACID FORMIC (Acid Hydrogen Carboxylic Acid Methanoic) $HCOOH$ Colorless liq., pungent odor. Sp. gr. 1.–178 M.P. 8.3 C. B.P. 100.8 C. Sol. water, alcohol, glycerine, ether. Uses: mfr. formates, organic esters, [illegible] acid, aromatic formates, a food preservative, silvering agent, deliming agent, preserving hides, mordant in dyeing and printing textiles, fermentation assist, in electroplating, in medicine.

ACID HYDROCHLORIC — See Acid Muriatic

ACID HYDRIODIC (Hydrogen Iodide) —HI M.W. 127.93 Fuming liq. Sp. gr. 4.373 M.P. —50.8 C. B.P. —35.5 C. Sol. water. Uses: mfr. iodides, intermediates, pharmaceuticals, dyes, perfumes, a general disinfectant, laboratory reagent, in medicine.

Acid Hydrobromic (Hydrogen Bromide) —HBr M W 80.92 Colorless or slightly yellow fuming liq Sp gr 2 71 (gas) M P −86 C B P −67 C Miscible water alcohol. Uses mfr bromides, intermediates, dyes, perfumes, pharmaceuticals a laboratory reagent in photography medicine.

Acid Hydrofluoric (Acid Fluorhydric, Hydrogen Fluoride Acid Fthoric) —HF M W 20.01 Colorless, fuming corrosive liq Sp gr 0.95 (gas) M P −92.3 C B P 19 44 C Sol water Uses mfr fluorides, inorganic chemicals, ashless filter paper in etching glass etching physical instruments fermenting yeasts treating ceramics purifying sugar as laboratory reagent electroplating reagent antiseptic in brewing

Acid Lactic (Acid Alphahydroxypropionic Acid Ethylidenelactic Milk Acid) —$CH_3CHOHCOOH$ Colorless or yellowish, syrupy liq Sp gr 1.2485 M P 18 C B P 119 C Sol water alcohol, ether Insol. benzol, carbon bisulphide. Uses mfr lactates, organic esters, pharmaceuticals, bread, fruit essences, extracts, syrups, confectionery, yeast as laboratory reagent finishing agent discharge in Turkey red dyeing flux for soft solder, assist in dyeing silks and other textiles mordant in dyeing and calico printing in deliming hides vegetable tanning bating and plumbing feathers hat dyeing in medicine

Acid Muriatic (Acid Hydrochloric, Acid Chlorohydric Hydrogen Chloride) —HCl M W 36 46 Colorless or slightly yellow solution of gas in water pungent odor Sp. gr 1 194 at 8.8 C M P −111 C Sol water alcohol, ether Uses mfr chlorides, acids, carbon dioxide chlorine, sal ammoniac, inorganic preparation, organic and intermediate chemicals, aniline, resorcin, pharmaceuticals, synth perfumes, azo dyes, coal tar colors, pyrotechnic compositions, phosphate from bones, bone and animal glues treating oils, fats and tallow, purifying sand and clay chrome tanning dehairing hides etching, pickling and mercerizing agent laboratory reagent electroplating process engraving reclaiming rubber, purifying spent bone-black sour in bleaching textiles assist in dyeing and printing in medicine

Acid Nitric (Aqua Fortis, Hydrogen Nitrate, Acid Azotic) —HNO_3 M W 63.02. Colorless or yellowish fuming liq Sp. gr 1.502. M P −42 C B P 86 C Miscible water Uses mfr sulphuric acid metallic nitrates, aqua regia, phosphoric and oxalic acids, nitro derivatives of benzene naphthalene, anthracene and derivatives, synth drugs, camphor azo, diazo and aniline dyes, nitroglycerine Berlin blue nitrocellulose, nitrostarch T.N T., picric acid, bats celluloid, rubber rubber substitutes, rayon, as nitrating and pickling agents laboratory reagent metallurgical solvent assist in dyeing silks separating gold and silver gilding brass engraving and etching steel electroplating dyeing furs in engraving in medicine.

Acid Oxalic (Acid Ethandioic) —$CO_2HCO_2H.2H_2O$ M W 126.05. Colorless, odorless cryst Sp gr 1 653 M P 101.5 C Sol. water alcohol, ether Uses mfr glycerine, pure dextrin, cream of tartar intermediates, dyestuffs, malachite green diphenylamine blue pyrotechnics, glues, writing and printing inks, blue ink, metal and shoe polishes, blue print paper celluloid rayon marble, metal and coal cleanser purifying tartaric acid and stearine as laboratory reagent tanning agent bleaching straw, rust and stain remover laundry detergent mordant in dyeing and printing textiles discharge in indigo printing and dyeing bleaching flax accelerating chroming of wool in engraving treating rubber Very poisonous.

Acid Perchloric (Fraude s Reagent) —$HClO_4$ Colorless liq Sp. gr 1 64 B P 39 C (56 mm) Sol water Uses mfr ester derivatives, monochlorohydrin perchlorate explosives, matches as laboratory reagent electroplating with lead in medicine

ACID PHOSPHOROUS.—H_3PO_3. Moist, colorless cryst. acid. Melts somewhat below 73 C Decomposes when heated to 200 C with liberation of phosphine. Forms mono and dibasic salts. Extremely sol. in water very hygroscopic. Uses reducing agent mfr phosphites.

ACID PICRIC —$C_6H_2(NO_2)_3OH$ Yellow cryst. sol. water alcohol, ether Uses mfr picrates, explosives, dyes, in medicine.

ACID SALICYLIC (Acid Orthohydroxybenzoic) —$C_6H_4(OH)(COOH)$ M W 138.05 White crystalline, needles or powder Sp. gr 1 443. M.P 156 -159 C Sol alcohol, ether oil or turpentine acetone. Uses mfr salicylates, esters, synth. drugs, salol, aspirin, salophen, artifical oil wintergreen, intermediates, azo dyes catgut, parchment paper perfume esters as preservative foods, glues and hides in medicine

ACID SULPHAMIC.—HO—SO_2—NH_2. M W 97.02. Crystalline, nonhygroscopic mineral acid M P 205 C., with decomposition. Uses reagent in mfr azo dyes and lake colors leather tanning agent ingredient in cleaning compounds acidimetric standard in analytical work intermediate for chemical syntheses.

ACID SULPHURIC (Dihydrogen Sulphate, Oil of Vitriol, Battery Acid, Dipping Acid Oleum, Hydrogen Sulphate) —H_2SO_4. Colorless to dark brown oily liq Sp gr 1.8342. M P 10 46 C B P 210 -238 C Sol. water Uses mfr inorganic and organic acids, nitric and hydrochloric acids, technical gases, hydrogen, hydrogen sulphide, carbon dioxide, sulphates of metals, hydrogen peroxide, alums, salt cake, synth. drugs, synth. perfumes halogens, dyes, T.N T picric acid, smokeless powd gun-cotton, nitroglycerine, sol. cotton, nitro-starch, nitro-sugar stearin, fatty acids, liq glue yeast, mineral pigments, parchment paper celluloid and pyroxylin plastics, candles, soap, glucose syrups and refining sugar rayon as sulphonating agent in making intermediates and organic chemicals fungicide laboratory reagent pickling agent for iron and steel drying agent mordant in dyeing and printing textiles sour in bleaching cottons resist in dyeing woollens, in storage batteries and ordinary cells purifying fats and oils solubilizing superphosphates dehydrating foods recovering ammonia as ammonium sulphate neutralizing lime in glue making tanning refining precious metals electroplating cleaning bronze and brass electrolytic refining of copper metallurgy of cobalt, nickel, magnesium and other metals washing tars refining crude oils and petroleum products photographic processes process engraving refining waxes reclaiming rubber recovering fatty acids carbonizing wool mercerizing cotton in medicine

ACID SULPHUROUS —H_2SO_3. Colorless, suffocating liq or gas. Gas constants. Sp. gr 1 43368 M P —76.1 C B P 10 C Sol. water Uses mfr intermediates, sulphites, bisulphites, hydrosulphites, alum, salt cake, sulphuric acid, flour food products, sulphite liquors as preservative fruits, nuts foods and wines laboratory reagent refrigerant in ice machines fire extinguisher in mine fires in bleaching fats, oils, silk, wool straw hats, wicker work, sponges, feathers, furs, plumes softening hides tanning smelting and refining ores, disinfecting ships refining crude oils and paraffine refining and bleaching sugar in medicine

ACRIDINE.—$C_{13}H_9N$ Yellowish-white solid slight. sol. water

ACROLEIN (Acrylic Aldehyde Propenal, Allyl Aldehyde Ethylene Aldehyde) — CH_2CHCHO M W 56.03 Col liq Sp. gr 0.84 M.P —87 7 C B P 52 5 C Sol water alcohol, ether inflam Uses in petroleum solvent extraction processes organic synthesis in chemical warfare

ACRYLONITRILE (Propene Nitrile) CH_2CHCN M W 53.03 Colorless inflammable liquid B.P 77 C M P —83 C to —84 C Partially miscible with water Uses intermediate in production of synthetic rubbers

ALCOHOL ALLYL (Propenol Propenyl Alcohol) —CH_2CHCH_2OH M W 58.05 Colorless liq of pungent odor Sp gr 0.855 M P −129 C B P 97 C Sol alcohol water, ether Uses mfr intermediates organic chemicals, military gas, pharmaceutical derivatives.

ALLYL AMINE (3-Amenipropylene) —$CH_2CHCH_2NH_2$ M W 57.08 N 24.53% Colorless liq burning taste strong ammonia odor causing sneezing and tears. Sp. gr 0 744 Boils 55 –58 C Miscible with water alcohol chloroform, ether

ALPHA PINENE —Sp gr 0.8630 at 15.3/4 C Ref ind at 20 C. 1.4660 B range 150 to 158 C. Alpha pinene is the principal constituent of spirits of turpentine comprising from 70 to 85 per cent of the usual commercial turpentine It is derived from the turpentine by chemical treatment and vacuum fractionation. It is largely used for the manufacture of synthetic camphor

ALPHANAPHTHYL ISOTHIOCYANATE —$C_{10}H_7NCS$. White crystalline odorless solid M P 553 C B P 147 C at 0 mm vacuum. Slightly sol. water sol in most organic solvent Uses insecticide and in insecticidal preparations

ALUM AMMONIA CHROME (Chromium Ammonium Sulphate Chrome Ammonium Alum) —$Cr_2(SO_4)_3(NH_4)_2SO_4 24H_2O$ Green or violet crystalline or powd. Sp. gr 1 719 M P 100 C Sol water alcohol Uses as mordant in tanning

ALUM POTASH CHROME (Chromium Potassium Sulphate Chrome Alum) — $Cr_2(SO_4)_3K_2SO_4 24H_2O$ Dark, violet-red cryst. Sp gr 1.83 (0 C) M P 89 C Sol water insol alcohol. Uses mfr porcelains, potteries inks, chromium salts waterproofing fabrics tanning agent photographic hardener and fixative mordant in dyeing and printing textiles.

ALUMINUM CHLORIDE (Chloralum) $AlCl_3 6H_2O$ M W 241 43. Yellowish white deliq granular cryst or powd M P 190 C (2.5 atms. pressure) B P 182 C (752 mm pressure) Sol water ether alcohol. Uses refining petroleum catalyst organic, inorganic compounds carbonizing wool assist in dyeing with indigo water disinfectant wood preservative in medicine

ALUMINUM FLUORIDE.—$AlF_3 3\frac{1}{2}H_2O$ M W 147.2 Colorless crystals that are soluble in water and lose 2 mol of H_2O when heated to 120 C anhydrous, has formula AlF_3. M W 83.97 A white powd. Sp gr 3 1 Sol water acids, alkalies or alcohol Uses glass and porcelain ware

AMMONIA AQUA (Ammonia Water Aqua Ammonium Ammonium Hydrate Ammonium Hydroxide Spirits of Hartshorn) —NH_4OH Varying properties according to compositions Colorless solution of gas in H_2O Sp gr 0 89 at 15 C (28 per cent) Tech grade usually 20 4 (26 Bé) B P 38.5 C Sol water Caution mix with H_2SO_4 or other mineral acids with care Uses mfr intermediate organic compounds, synth drugs, perfumes, ammonia soaps, ammonium salts, anhydrous ammonia, nitric acid (by synthesis) sodium cyanide soda ash, ammonium nitrate ammonium picrate, ammonium sulphate ceramics, glues, cements, inks, laboratory reagents, paper pulp blue print paper smelling salts a cleansing bleaching, fireproofing, and resin condensing agent photographic developer accelerator in phenolic condensations refrigerant vulcanization accelerator solvent in making cuprammonium rayon assist in dyeing and printing in fireproofing wood lubricating compositions tanning leather, in brass, steel, and metal industries electrotyping and photo-engraving scouring wool in sulphuric acid manufacture to furnish niter oxides by oxidation in medicine

AMMONIUM BICHROMATE (Ammonium Dichromate) —$(NH_4)_2Cr_2O_7$ M W 252 10 Orange-yellow needle cryst Sp gr 2.153. Decomposes on heating Sol. water alcohol Uses mfr inks, alizarine sporting

smokeless powd synth. perfumes purifying fats and oils pickling agent for candlewicks reagent in gum printing in process engraving photo-engraving and lithography as mordant in dyeing and printing Caution poisonous.

AMMONIUM BIFLUORIDE (Hydrogen Ammonium Fluoride, Ammonium Fluoride) —$(NH_4)FHF$ White cryst. Sp gr 1.211 Sol water Uses mfr ceramics, etching glass sterilizing agent laboratory reagent general disinfectant electroplating reagent mordant for aluminum.

AMMONIUM FLUORIDE (Meat Salt) —NH_4F White deliq crystalline. Sublimes. Sol. water slightly sol alcohol Uses mfr fluorides, etching glass as laboratory reagents, disinfectant and antiseptic in brewing mordant in dyeing and printing, improving sandy soils Caution should be packed in rubber containers.

AMMONIUM SILICOFLUORIDE.—$(NH_4)_2SiF_6$ M W 178.07 Sp gr 2.01 Colorless cryst. or white powd. Sol. water Uses disinfectant antiseptic.

AMYL ACETATE (Banana Oil, Amylacetic Ester, Isoamyl Acetate, Pear Oil Pentyl Acetate) —$CH_3CO_2C_5H_{11}$ M.W 130.11 Colorless liq banana or pear odor Sp. gr 0.866–0.869 (15 C) M P 75 C B P 147.6 C Sol. alcohol, ether Very slightly sol water Uses mfr gun-cotton smokeless powd., fruit flavors soft drinks, food preparations, confectionery artificial leather artificial pearls, fireproofing and waterproofing compositions, lacquers, waterproofed varnishes bronzing liquids, celluloid, collodium, photographic films, camphor as solvent in making nitrocellulose solvent in making rayons perfume and soap solvents combustible in standard photometric lamp in photo-engraving linoleum and oilcloth dyeing, printing and finishing textiles.

AMYLENE DICHLORIDE.—$C_5H_{10}Cl_2$ Liq Sp. gr 1.2210 B P 145 C Uses solvent in nitro cellulose, varnishes, lacquers and plastics general solvent.

ANTIMONY FLUORIDE (Antimony Trifluoride) —SbF_3 Grayish to white, hygroscopic cryst. M P 292 C Sp. gr 4.379 Sol water Uses mfr porcelains, pottery in dyeing.

ARSENIC RED (Arsenic Disulphide, Red Orpiment, Arsenic Bisulphide Realgar Red Arsenic Glass, Red Arsenic Sulphide Ruby Arsenic) — As_2S_2 Brownish-red amorp powd. Sp. gr 3.66 M P 307 C B P 565 C Sol. acids, alkalies. Uses mfr pyrotechnic preparation depilatory agent shot, paint, and varnish pigment dyeing textiles and calico printing. Poisonous.

ARSENIC TRICHLORIDE, Anhydrous (Arsenous Chloride) — $AsCl_3$ Colorless, fuming, corrosive oily liq Sp. gr approx. 2.163 at 15.5 15.5 C Distillation range 3 B.P 130.2° C Sol hydrochloric acid alcohol, ether Uses mfr drugs, ceramics, sneeze gas.

ARSENIC WHITE (Arsenious Acid Arsenious Oxide, Arsenous Anhydride, Arsenic Trioxide) —As_2O_3 M W 197.82. White, amorp. lumps cryst. or white powd., odorless. Sp. gr 3.86. Sublimes at 193 C Sol water alkalies, alkali carbonates, acids, alcohol. Uses mfr arsenic acid, arsenicals, aniline dyes, white fire ceramic enamels, fly poisons fly paper wheat smut killers, vegetable decomposition preventatives, boiler compounds, rat poisons, sheep dips, bullets and shot, Scheele's green, Paris green, etc., medicinal soaps blue green pink brown and other pigments, as clarifying agent and decolorizer glass hide preservative insecticide laboratory reagent treating hair for felt hat mordant in dyeing and calico printing fixative for aniline dyes determining strength of bleach for coloring metals in medicine Very poisonous.

Barium Sulphide (Barium Monosulphide).—BaS. Grayish-white powd. technical—brownish-black powd. in lumps. Sp. gr. 4.25 (15° C.). Infusible. Decomposes in water. Uses: mfr. barium salts, hydrogen sulphide gas, luminous paints; for producing rich shades of brown coloring on copper; vulcanizing rubber; weighting gutta percha; laboratory reagent; as depilatory.

Benzine (Petroleum Ether, Benzoline, Petroleum, Naphtha, Canadol, Benzinum Purificatum).—Mixture of hydrocarbons, principally CH. Colorless liq. Sp. gr. tech. 0.730–0.750 (15° C.). B.P. tech. 80–130° C. Sol. alcohol, benzene, chloroform, ether; insol. water. Uses: mfr. detergent soaps, printing and lithographic inks, rubber cements, paint and varnish removers; extracting perfumes; general solvent; solvent for oils, fats, greases, inks, rubber; extracting fats and oils; diluent in varnishes, paints and lacquers; linoleum and oilcloth waterproofing agent; degreasing and cleaning textiles; as fuel and illuminant; degreasing machines and hides; cleaning gloves, etc.

Benzol (Benzene, Coal Naphtha, Phenyl Hydride, Cyclohexatriene, Phene).—C_6H_6. M.W. 78.05. Colorless liq. Sp. gr. 0.879 (20° C.). M.P. 5.4° C. Flash point 15° C. B.P. 79.6° C. Sol. alcohol, ether; insol. water. Color minimum 21 saybolt. Uses: mfr. phenol, nitrobenzene, synth. drugs and perfumes, phenacetin, antipyrin, salicylic acid, saccharin, intermediates, organic chemicals, indigo dyes, picric acid; shoe polishes, blackings, spreading compounds, splicing solutions, dry cleaning preparations, paint removers, airplane dopes, varnishes, lacquers, photographic developers, rubber cements, textile soaps; cleansing textiles; preserving textile sizes; as solvent for and extracting waxes, resins, fats and oils; solvent ink, celluloid and rubber; enriching gas; in cements; degreasing glue stock; solvent in making artificial leather; as disinfectant; engraving and lithography; knock inhibitor in gasoline; in medicine.

Benzotrichloride (Phenylchloroform).—$C_6H_5CCl_3$. M.P. 4.8° C. Colorless to light yellow liq. having a pungent odor. Sp. gr. 1.375–1.383 at 15.5–15.5° C. Uses: organic syntheses.

Benzyl Chloride (Chlorotoluene, Chlorotoluol).—$C_6H_5CH_2Cl$. M.W. 126.51. Colorless liq.; unpleasant odor. Sp. gr. 1.103 (18° C.). M.P. 30° C. B.P. 179.4° C. Sol. alcohol, chloroform, ether; insol. water. Uses: mfr. intermediates, organic chemicals, benzaldehyde, benzoic acid, esters, salts, perfume esters, synthetic drugs, basic dyes, photographic developers, artificial resins; in medicine.

Beryllium Fluoride (Glucinum Fluoride).—BeF_2. M.W. 47.02. Sp. gr. 1.986. M.P. 800° C.

Beta Naphthol (Naphthol [B or P], Isonaphthol, Betamonohydroxy naphthalene).—$C_{10}H_7OH$. White or colorless leaflets or powd. Sp. gr. 1.217 (4° C.). M.P. 122° C. B.P. 285–6° C. Sol. alcohol, ether, chloroform, benzene, oils, alkaline solutions. Slightly sol. hot water. Uses: mfr. synth. drugs and intermediates, synth. dyes; in medicine.

Beta Trichlorethane (Vinyl Trichloride).—$CH_2Cl.CHCl_2$. M.W. 133.40. Colorless liq. B.P. 114° C. Miscible with alcohol, ether and other organic solvents, but is practically immiscible with water. Uses: as solvent for oils, fats, waxes, tars, natural resins and free alkaloids. With small amounts of some alcohols it is a solvent for cellulose acetate. Toxic to a certain extent.

Bromine.—Br_2. Reddish-brown, fuming liq. Sp. gr. 3.1883 (0° C.). M.P. −7.3° C. B.P. 58.7° C. Sol. water, alcohol, ether, potassium bromide, alkalies, carbon disulphide. Uses: mfr. bromides, hydrobromic acid, Prussian blue, poison gases, tetraethyl gasoline, dyes, pharmaceuticals; as battery depolarizer; disinfectant of rooms and buildings; oxidizing and brominating agent in making inorganic and organic compounds; extracting gold; in medicine.

BROMOBENZENE (Bromobenzol, Monobrombenzene, Phenyl Bromide) —C_6H_5Br Colorless liq Sp gr 1 49528 (20 C) M.P 30 6 C B.P 156.15 C Insol. water sol. alcohol, ether Uses mfr intermediate chemicals, benzoic acid.

CALCIUM ARSENATE (Tricalcium Orthoarsenate) —$Ca_3(AsO_4)_2 + 3H_2O$ White powd. Sp gr 3.23. Decomposes on heating Very slightly sol. water Uses as germicide, insecticide, fungicide.

CALCIUM ARSENITE.—$CaAsO_3H$. White amorp. powd. Insol. water Uses mfr germicidals, insecticides.

CALCIUM BISULPHITE.—$Ca(HSO_3)_2$. Exists only in solution and is really a solution of CaSO in aqueous solution of SO_2. Slightly yellowish liq Sp. gr 1.06 (15 C.) Sol. water acids. Uses mfr chromium bisulphide anti-chlor in bleaching textiles bleaching sponges, general preservative, sulphite pulp disinfectant in washing barrels in brewing in medicine. Must not be permitted to come in contact with common metals.

CALCIUM CHLORIDE —$CaCl_2H_2O$ White deliq crystalline or amorp. Tech. article is either solid or flake or in solution. Sp. gr 2.152 (20 C) and 1.654 resp. M.P 774 C and 20 48 C resp

CALCIUM CYANAMIDE (Cyanamide, Lime Nitrogen Nitrolim) —$CaCn_2$. Black, crystalline lumps or powd. Sp. gr 1.083. Decomposes in water to liberate ammonia. Uses mfr ammonia, nitrogen products, urea, thiourea, guanidine, pharmaceuticals, caronal in fertilizer as cementation and hardening steel

CALCIUM CYANIDE (Powdered Cyanic Acid) —$CaCN_2$, also $Ca(CN)_2$.-$3CaO\ 15H_2O$ White powd (pure) tech. grades grayish-black. Decomposes on heating Sol. water Uses mfr cyanamic hardening iron insecticide and fungicide for killing rodents.

CALCIUM DICHROMATE.—$CrCr_2O\ 3H_2O$ M W 810.15. Brownish-red deliquesce, crystals. Very soluble in water Keep well closed.

CALCIUM FLUORIDE.

CALCIUM HYPOCHLORITE.—$Ca(OCl)_2$. Dry stable powd. containing 70 per cent available chlorine. Uses as laundry and textile bleach germicide and deodorant in dairy food plants, swimming pools, water works, etc.

CALCIUM OXIDE (Lime, Burnt Lime, Calx Quicklime) —CaO M W 56 08. White hard lumps. Sp. gr 3 40 M P 2.572 C Sol. acid Uses for making mortar plaster mfr of chlorinated lime making calcium hyperoxide which is used medicinally etc

CALCIUM SULPHITE.—$CaSO_3\ 2H_2O$ White powd. Loses water at 100 C Sol. sulphurous acid slightly sol. water Uses mfr pulp food preservative discoloration retarder general antiseptic and disinfectant antichlor in bleaching textiles disinfectant in various fermentation processes.

CARBON BISULPHIDE (Carbon Disulphide) —CS_2. Colorless liq Odorless when pure, disagreeable otherwise Sp gr 1 2022 (0 C) M P −111 6 C B P 46.3 C Flash point 20 C Ignition point under 200 C Sol alcohol, ether slightly sol water Uses mfr rayon varnishes paint and varnish removers rubber cements, germicides, cyanides, carbon tetrachloride synth hydrocarbons, ammonium sulphocyanide matches, motor fuels, moth exterminator vermin killer cold vulcanizing agent rubber gutta percha, resin and wax solvent preservative and insecticide refrigerant degreasing wool extracting medium for resin and waxes, essential oils from flowers, fat and oil from oilseed soil disinfectant general solvent laboratory reagent solvent of alkaloid and extracting aromatic substances and pharmaceutical products from seeds, roots etc, purifying paraffin solvent for separation of bitumens and sulphur Vapors highly inflam Mixed with air explosive

CARBON TETRACHLORIDE (Perchlormethane Benzinoform Tetrachlormethane) —CCl_4. Colorless, non-inflam liq., peculiar odor M W 153.8 Sp gr 1.503 (25 C) Pounds/gal., 13.28 M P −23 C B P 76 C V D (15 C) lbs./cu ft. 0.408. Latent heat of vap. B T U/lb 83.7 S.H cal./kg/°C or B T U./lb/ F 0.203 (25 C) Sol alcohol, benzene ether and most of the fixed oils very slightly sol water Uses mfr leather carbineol, chloroform organic and intermediate chemicals, acetic anhydride, dyes, lacquers, paints, varnishes, dry colors, printing inks, linoleum metal polishes, rubber cements, general solvent and extracting agent for waxes resins, fats, oils, perfumes from flowers, paraffin rubber etc., degreasing wool, cotton waste and bones in glue making in dry cleaning fire extinguisher in cleansing compositions rubberizing fabrics rendering benzene uninflam. laboratory reagent recovering tallow and ceresin wax preserving grain in medicine

CARBONYL CHLORIDE (Phosgene) —$COCl_2$. Colorless liq Sp gr 1.392 M.P 104 C B P 8.2 C Uses mfr methyl violet and other dyestuffs, intermediates and organic chemical , synthetic drugs, perfumes, military poison gas bleaching sand for glass making chlorinating agent in many chemical processes.

CHLORACETOPHENONE (Phenacyl Chloride Chloroacetophenone) —C_6H_5-$COCH_2Cl$. M.W 154.51 M.P 59 C Moisture less than 0.2 per cent. Light brown crystalline solid Uses tear gas in cartridges, grenades and candles. Effective in concentrations as low as 1 part in 3 000 000 of air

CHLORACETYL CHLORIDE.—$CH_2Cl.COCl$. M W 112.9 Clear colorless liquid with sharp odor Very irritating to eyes and mucous membranes Sp gr 1 495 at 0/4° C Weight per gal 12.5 lbs. at 0 C B P 105–106 C Decomposes in water and alcohol. Uses mfr chloracetophenone, in organic synthesis.

CHLORAMINE T, DI (N Dichloro-p-toluenesulphonamide) —$CH_3C_6H_4SO_2$-NCl_2. M W 240.04 Pale yellowish crystals or powder M P [illegible] C Soluble in water and most organic solvents.

CHLORAMINE T MONO (Paratoluenesulphonamide Sodium Salt) —CH_3-$C_6H_4SO_2NClNa.3H_2O$ M W 281.62 White, crystalline powder prepared from p-toluenesulphonamide and aqueous sodium hypochlorite Sol in water and most organic solvents. Uses antiseptic and germicide chlorinating and oxidizing agent.

CHLORCRESOL (Chlormetacresol) —$C_6H_3CH_3OH$ Cl White crystalline powd cresol odor B P 236 C Sol. alcohol benzene, chloroform Uses mfr oxymonoazo dyes, parachlormetacresol, $CH_3C_6H_3Cl$ (4) HO dyes preservative glue pastes and inks as disinfectant.

CHLORINATED DIPHENYL and CHLORINATED DIPHENYL OXIDE —Pale colored derivatives of diphenyl Range from viscous liquids to hard solids. Uses plasticizers, lacquer waterproofing paper, di-electrics.

CHLORMETACRESOL (Chloroxymethylbenzene) – $C_6H_3CH_3OH$ Cl White crystalline powd cresol odor B P 236 C Sol. alcohol, benzene chloroform Uses mfr oxymonoazo dyes, parachlormetacresol, $CH_3C_6H_3Cl$ (4) HO Preservative, glue pastes and inks as disinfectant.

CHLORMETAXYLENOL $C_6H_2(CH_3)_2OH$ Cl M P 112.5 C White. Solid. Sol. alcohol caustic soda Uses mold preventative fungicide and germicide

CHLOROACETONE —CH_3COCH_2Cl Chloroacetone is a very powerful lachrymator and will blister the skin on contact. Adequate precautions should therefore be taken in handling this product.

CHLOROFORM (Trichloromethane, Formyl Trichloride Methenyl Trichloride) —$CHCl_3$. M W 119.38. Colorless volatile liq characteristic odor Pounds/gal 12.52 Sp gr 1.5025 (12.5 /4 C) M P 63.2 C B P 61.20 C V D (15 C) lbs./cu ft., 0.315 Latent

heat of vap., B T U./lb 106.4 S.H., cal./kg./°C or B T U./lb./°F 0.234 (20 C) Sol alcohol, ether Slightly sol water Uses mfr dyes, derived pharmaceuticals solvent for extracting essential oils fatty oil, rubber and gutta percha solvent dissolving resins and alkaloids, fire extinguishing liquids to lower freezing point cleansing delicate fabrics and fine garments.

CHLOROPICRIN (Chlorpicrin, Nitrochloroform, Nitrochloromethane, Trichloronitromethane) —CCl_3NO_2. M.W 164.38. Colorless liq Sp gr 1.692. M.P −64 C B P 112 C Sol. alcohol ether Uses killing silkworm in cocoons as military poison gas insecticide disinfectant in medicine.

0-CHLORO-2 PHENYLPHENOL.—$C_6H_5C_6H_3ClOH$ M W 204.5. Colorless to light straw-colored, viscous liquid with a slight characteristic odor tech. grade deposits crystals on standing at 15 C B P 315 -31 C with slight decomposition. Sp. gr 1.24 at 24/4 C Weight per gal 10.6 pounds at 77 F M.P 6 C Refractive index at 30 C Sp. gr 1.6227–1.6237 Sol in sodium hydroxide solutions and most organic solvents insol water Uses as a germicide and fungicide.

2-CHLORO-4-PHENYLPHENOL.—$C_6H_5C_6H_3ClOH$ M W 204.5 Light-colored crystalline solid. B.P at mm 160 -162 C M P above 77 C Sol. sodium hydroxide solutions and most organic solvents insol. in water

2-CHLORO-4-tert-AMYL PHENOL. Water white liquid, aromatic odor Sp. gr at 20 C 1 11 dist. range (Engler) 233 -264.5 C Uses mfr insecticides and antiseptics additive compounds for lubricating oils.

CHLOR-THYMOL.—Germicide. Reported 120 times the germicidal strength of phenol, when tested against Staphylococcus aureus.

COPPER ARSENITE (Scheele's Green Cupric Arsenite Copper Orthoarsenite, Mineral Green, Swedish Green) —$CuHAsO_3$ M W 187.51 Light green, amorp powd. Decomposes on heating Sol acids, alcohol insol. water Uses pigment paint, varnish and wallpaper printing calico insecticidal compositions in medicine

COPPER NAPHTHENATE.—11–13 per cent copper Green solid Uses preservation cloth wood, paint against mildew dry rot in paints to prevent barnacle growth.

COPPER SULPHATE (Blue Vitriol Blue Stone, Blue Copperas, Roman Vitriol, Salzburg Vitriol) —$CuSO_4.5H_2O$ Blue crystalline powd. or lumps Efflorescent (when dehydrated almost white) Sp. gr 2.284 (1 °C) Loses water at 110 C Sol. water alcohol Uses mfr copper salts, printing inks, electric batteries, Paris green Bordeaux mixture casein glues a mordant in printing and dyeing textiles germicide, insecticide and fungicide laboratory reagent wood preservative, dehydrating agent (anhydrous form) pigment in paints and hair dyes copper plating etching, and in electrolytic baths in the sweetening process in refining for drawing wire process engraving and photo-engraving tanning leather purifying drinking water and swimming baths preserving pulpwood and ground pulp for coloring metals in medicine

CREOSOTE (Coal-tar) A used in wood preserving, creosote is a distillate of coal tar produced by high-temperature carbonization of bituminous coal It consist principally of liquid and solid aromatic hydrocarbons and contains appreciable quantities of tar acids and tar bases it is heavier than water and has a continuous boiling range of at least 125 C beginning at about 200 Official definition, American Wood Preservers Association

CREOSOTE (Wood Creosote Beechwood, Kreosote Creasote) —Colorless or faintly yellow liq smoky odor Sp. gr 1.070 (25° C) B.P 203 220 C Sol water, alcohol ether Uses mfr creosote carbonat a antiseptic and disinfectant ore flotation agent in medicine

CRESOL (Ortho, Meta and Para) —$CH_3C_6H_4OH$ Ortho—white, crystalline powd., phenol-like odor Sp. gr 1.0511 M P 30 4 C B P 191 C Meta—colorless to yellow liq., phenol-like odor Sp. gr 1.0419 M.P 12 C B P 202 C Para—colorless crystalline, phenol-like odor Sp. gr 1.039 M.P 34.5 C B P 202° C All sol. ether alcohol, chloroform. Uses (Ortho) mfr coumarin, disinfectants, coumarone, fumigants (Meta) mfr photographic developers, nitrocresol and nitrocresol explosives, disinfectant soaps, printing inks, paint and varnish removers as leather preservative removing ink from newsprint solvents and preservative for glues pastes and grinding compounds softening and reclaiming rubber basis in making synthetic resins, perfumes, pharmaceuticals. (Para) mfr creosotinic acid dyes disinfectants and fumigants in medicine.

CYCLOHEXANOL (Hexahydrophenol, Hexalin) —$C_6H_{11}OH$ M W 100 09 Colorless, hygroscopic liq camphor-like odor Sp gr 0.962 M.P 23.9 C B.P 161.5 C Slightly sol. water Uses mfr nitrocellulose varnishes and lacquers, disinfectants, germicides and insecticides as general solvent in chemical processes, synthetic rubber textile soaps, detergents and in deodorizing fish oil soaps dry cleansing agent substitute for camphor in celluloid and plastics in preserving wood cutting, boring, drilling and machining oils wax and encaustic preparations glazing leather

DIBUTYL SEBACATE.—$((CH_2)_4COOC_4H_9)_2$ Water white liquid. Uses solvent plasticizer

DIMETHYLANILINE.—$C_6H_5N(CH_3)_2$. M W 121.09 Yellow or brown liq Sp gr 0.962 (15 C) M P 1 67 C B P 102.5 –103.5 C Sol alcohol, ether Uses mfr dyes, methyl violet, crystal violet, methyl green methylene blue malachite green auramarine Michler's ketone, intermediates, organic chemicals, trinitrophenylmethylnitramine as rubber accelerator

DIMETHYLAMINE.—$(CH_3)_2NH$ Gas. Is compressed to liq state also occurs in aqueous state Aqueous solution is colorless miscible with alcohol, water Sp gr 0 680. B P 7.2 C Sol. water alcohol ether Uses mfr intermediates in organic synthesis as accelerator in rubber insecticide for boll weevil.

DINITROBENZENE.—$C_6H_4(NO_2)_2$ M W 168 14 Colorless scales. M.P 11 C B P 319 C Very slightly sol. in water slightly sol. in alcohol soluble in benzene Uses mfr dyes.

DINITROCHLOROBENZENE (Dinitrochlorobenzol) —$C_6H_3(NO_2)_2Cl$ Colorless needles Sp. gr 1.0867 1.697 M P 37 1 –53 C (depending on position of NO_2 and Cl groups in molecule) Sol alcohol insol water Uses mfr sulphur black dyes, dinitrophenol substituted diphenylamines, synthetic perfumes.

DINITRO ORTHO CRESOL.—$C_7H_6O_5N_2$ M W 198.2 M P 104 C B.P 312 C Uses known as saffron substitute orange-colored poisonous dye

DINITROPHENOL (Alpha-Dinitrophenol) —$C_6H_3OH(NO_2)_2$ (a) 2 3, (b) 2 4 (c) 6 Yellow crystalline powd (a) Sp gr 1.683 M.P 144 C (b) Sp gr 1 683 (c) M P 111.6 C M P 61 –78 C Sol alcohol benzene chloroform slightly sol. water Uses mfr sulphur and azo dyes, ammonal black sulphur blacks, picramic acids picric acid, amidol as wood preservative

DINITRORESORCINOL (Solid Green O Paste, Chlorin Diquinoyldioxime) —$C_6H_2(NOH)_2O_2$ M W 200.03 Yellow leaves. Sol alcohol, dilute alkalies slightly sol water Uses in dyeing green colors where iron is used as mordant.

DINITROTOLUENE (Dinitrotoluol) C_6H_3—$CH_3(NO_2)_2$ (a) 2 4, (b) 3 4 (c) 3 5 Yellow cryst. (a) Sp gr 1.521 M.P 09 0 C (b) Sp. gr 1.26 M.P 59.8 C (c) M P 92.3 C Sol. alcohol ether insol. water Uses mfr T N T organic chemicals, tolidines, toluidines, sulphur and azo dyes in dynamite to prevent freezing.

DICHLORAMINE T (Paratoluenesulphonedichloramide) —$CH_3C_6H_4SO_2NCl_2$. M W 240.06. Pale yel. cryst. or cryst. powd 28–30 per cent active Cl. Sol. benzene, chloroform, carbontetrachloride, chlorinated paraffin hydrocarbons. Decomp by alcohol. Almost insol water M P about 80 C Decomposes on standing Uses germicide.

DICYCLOHEXYLAMINE.—Water white liq with faint odor resembling cyclohexylamine. B P at 760 mm., 255.8 C crystallizing pt. −0 1 C Sp. gr at 25/25 C, 0.9104 flash pt. 100 C fire pt. (sustained combustion) 100 C Slightly sol water sol in all common organic solvents and miscible with cyclohexylamine Does not form an azeotropic mixture on distillation with water A strong base Uses organic synthesis as an insecticide plasticizer corrosion inhibitor mfr dyes, emulsifying agents, dry cleaning soaps acid gas absorbents.

DI-ORTHO-TOLYLGUANIDINE.—$NH\,C(NHC_6H_4CH_3)_2$. White powd. Sp gr 1.10. M P 179 C Sol. alcohol, water Uses rubber accelerator

DIPENTENE (Terpene) —Hydrocarbons with the general formula $C_{10}H_{16}$. Density 0.865 Colorless liq Insol water alcohol, ether B.R. 160 –190 C (90%) Uses flavoring, in medicine.

DIPHENYLGUANIDINE (Melaniline D P G Salt) —$C_{13}H_{13}N_3$. White, crystalline powd or needles. M P 147 C Decomposes at 170 C Sol water alcohol. Uses rubber accelerator

EPICHLOROHYDRIN (Chloropropylene Oxide) $CH_2ClCHOCH_2$ M W 92.52 Colorless liq Miscible alcohol, ether B.P about 117 C Uses solvent for resins, mfr intermediates, lacquer for negatives, solvent for nitrocellulose, mfr Zapon and other lacquers, cement for celluloid, test for nicotine (Melzer)

ETHYL ACETATE (Acetic Ether Æther Aceticus, Vinegar Naphtha) — $CH_3COOC_2H_5$. Colorless, inflam liq, fragrant odor Sp. gr 0.9003 M P −82.4 C B P 77 15 C Sol. water alcohol chloroform, ether Uses mfr synth dyes, drugs and perfumes, intermediate chemicals, artificial horse hair for brushes, phosgene gas solvent for pyroxylin and nitrocellulose plastics, organic chemicals, aceto-acetic ester of nitrocellulose in artificial leather artificial fruit flavors, smokeless powd nitrocellulose varnishes, paints and dopes, perfumes, photographic films and plates, rayon cleaning textiles in medicine

ETHYL BENZENE $C_6H_5(C_2H_5)$ B P range 134 8 –136 C at 760 mm Sp. gr 0.866 at 25 25 C dielectric constant 2 34 flash pt. 20 C fire pt 21 C Uses organic synthesis, solvents for plastics, resins.

ETHYL BROMIDE (Bromic Ether Bromomethane Ethyl Hydrobromic, Monobromoethane) C_2H_5Br Colorless inflam volatile liq Sp. gr 1 450 B P 38 C (13 C) Sol alcohol, ether sparingly sol. water Uses mfr intermediates organic chemicals, synthetic dyes, drugs and perfumes a refrigerant in medicine

ETHYL CHLORIDE (Monochlorethane Chlorethane Hydrochloric Ether Muriatic Ether) C_2H_5Cl Gas Also colorless, highly inflam. liq Sp. gr 0.9 14 B P 12 3 C Miscible alcohol, ether slightly sol water Uses a refrigerant solvent for phosphorus, fats, oils resins waxes laboratory reagent alkylating agent in making intermediates organic chemicals dyes, etc Insecticide ingredient in medicine

ETHYL FORMATE (Formic Ether) $HCO_2C_2H_5$. Colorless, inflam liq Sol water alcohol, ether Uses as an insecticide larvacide in mfr drugs, perfumes in medicine

ETHYL MERCAPTAN C_2H_5SH M W 62 07 Volatile liquid of extremely strong, skunklike odor B P C Sp. gr 0 840 (25 25 C) Flash point about 3 F Uses warning agent, odorizer in natural and petroleum fuel gas systems warning agent indicating overheating of machinery when sealed in a low-metal alloy within the machine

ETHYL MERCURIC PHOSPHATE.—Insecticide, wood preservative.

ETHYL MONOBROMACETATE.—$CH_2Br\,COOC_2H_5$. M W 167 Colorless to slightly yellow liquid, very irritating to the eyes. Sp. gr 1.507 at 25 /4° C Weight per gal. 12.5 pounds at 25 C Boiling range 158 –160 C with slight decomposition completely miscible alcohol, ether insol. water Uses mfr tear gases.

ETHYL MONOCHLOROACETATE (Monochloracetic Ether) —$CH_2Cl.COOC_2H_5$ Colorless liq., pungent odor Sp gr 1 157 (15° C) B P 144 C Sol alcohol ether insol water Uses mfr intermediates, organic chemicals. Vapors injurious to eyes.

2 ETHYL 3-PROPYL ACROLEIN (2-Ethylhexenal) —$C_8H_{14}O$ M W 126.19 Yellow liquid of powerful irritant odor B.P 175 0 C Uses warning agent for detecting leaks in insecticides as an odorant in chemical syntheses.

ETHYLENE BROMIDE (Dibromoethane, Ethylene Dibromide) —CH_2BrCH_2-Br Colorless liq., chloroform-like odor Sp gr 2 180 (15 C) M.P 9 –10 C B P 129 –131 C Miscible alcohol, ether Very slightly sol water Poisonous. Uses mfr organic chemicals, ethylene glycol, piperazin, intermediates synthetic drugs solvent in making celluloid in medicine.

ETHYLENE DICHLORIDE (Ethylene Chloride Dichloroethane) —CH_2Cl CH_2Cl Colorless liq., pleasant chloroform-like odor M W 96.9 Sp gr 1.278 (15 /4 C) Sol only very slightly sol in water alcohol, ether Uses mfr intermediate, ethylenediamine, glycol monosalicylate, glyco monocinnamate tobacco extracts, organic chemicals, cleaning fluids extracting nicotine from tobacco for food fumigating with alcohol rubber soap and degreasing in medicine.

ETHYLENE GLYCOL MONOBUTYL ETHER (Butyl Cellosolve) —$OHCH_2CH_2$-OC_4H_9 Liq Sp gr 0.9017 at 20/20 B P 170 0 C Sol. alcohol ether Uses solvent in paints, varnishes, lacquers, plastics.

ETHYLENE GLYCOL MONOETHYL ETHER (Cellosolve) —$OHCH_2CH_2OC_2H_5$ M.W 90.08 Liq Sp gr 0.9311 at 20 /20 C B.P 133.1 C Sol alcohol and water ether Uses solvent in paints, varnishes, plastics also as a dye solvent

ETHYLENE GLYCOL MONOETHYL ETHER ACETATE (Cellosolve Acetate) $C_2H_5OCH_2CH_2OOC\,CH_3$ M W 132.00 Liq Sp. gr 0.9747 at 20 /20 C B P 156.2 C Sol alcohol, ether Uses solvent in cellulose plastics and lacquers.

ETHYLENE GLYCOL MONOMETHYL ETHER (Methyl Cellosolve) —CH_3OCH_2-CH_2OH M W 76 00 B P 124.3° C Water-white liq Sp gr 0 9660 at 20 /20 C Uses solvent for low viscosity cellulose acetate nitrocellulose with petroleum hydrocarbons provides thinner for certain varnishes solvent for dyes sealing moisture-proof transparent wrapping in dry-cleaning soaps.

EUGENOL —$C_{10}H_{12}O_2$ Colorless, oily liq with odor of cloves. B P 247 C Slightly sol water misc alcohol, ether Uses in perfumery

FORMALDEHYDE —HCOH Colorless liq., suffocating, pungent odor Sp. gr 1.075–1 081 B P (gas) —21 C Miscible water alcohol

FURFURAL (Furfuraldehyde Furol, Artificial Oil of Ants, Furfurol Furfuranocarboxylic Aldehyde, Pyromucic Aldehyde, Furfuryl Aldehyde, Furfanecarbonal) —C_4H_3O—CHO M W 96.03. Colorless liq turning to dark amber upon exposure Characteristic penetrating odor Sp gr (tech) 1 159–1 161 (at 20 C) (ref) 1 160–1 161 B.P 160 162° C M P 38 5 C Sol alcohol, benzene Solvent uses purification of mineral oils, wood rosin anthracene synthetic resins, textile industry, shoe dyes, paint and varnish remover varnish gums, lacquer formulation. Biological fungicides, bactericides, preservatives, tree wound dressing, fly repellents Aldehyde resins, tanning (leather glue and casein) mfr of furan compounds, flotation agents.

HEXACHLORNAPHTHALENE.—$C_{10}H_2Cl_6$. M.W. 334.8. Melting point 135 C. Sol. in organic solvents, insol. in water. Yellow to pale yellow waxy solid in lump form. Uses: In compounds for insulating electric cable.

HYDRAZINE SULPHATE (Diamine Sulphate).—$(NH_2)_2H_2SO_4$. Colorless cryst. or white crystalline powd. M.P. 254 C. Sol. water, insol. alcohol. Uses: as fungicide and germicide, reducing agent, metallizing mirrors.

HYDROGEN FLUORIDE.—HF. M.W. 20.01. Colorless fum. corros. liq. or gas. M.P. −92.3 C. B.P. 19.4. Sol. water. Uses: etching of glass, production of fluorides, pickling metals, ceramics, textiles.

IODINE (Iodum).—I_2. Purplish-black crystalline scales. Sp. gr. 4.66. M.P. 114.2° C. B.P. 184 C. Sol. alcohol, carbon bisulphide, chloroform, ether, glycerine, alkaline iodide solution; slightly sol. water.

ISOPHORONE.—$C_9H_{14}O$. M.W. 138.20. Liq. of irritating, somewhat toxic odor. B.P. in the range 205–220 C. Sp. gr. 0.9227 at 20/20 C. Sol. in most organic solvents, including gasoline. Uses: solvent for various oils, fats, resins and gums, intermediate in mfr. plasticizers, flotation agents, rubber chemicals, etc.

MERCURIC CHLORIDE.—$HgCl_2$. M.W. 271.52. White crystalline powd. Sp. gr. 5.42. M.P. 275 C. B.P. 301 C. Sol. water, alcohol, ether, pyridine, acetic acid ester.

MERCURY AMMONIATED (Ammoniated Mercury Chloride, White Precipitate, Amido-Mercuric Chloride).—$HgNH_2Cl$. M.W. 252.08. Contains 78–80% Hg. White powd. earthy styptic, metal taste. Sol. acids. Insol. water, alcohol.

MERCURY CYANIDE (Mercuric Cyanide).—$Hg(CN)_2$. M.W. 252.65. Colorless, transparent prisms. Sp. gr. 4.018. M.P. decomposes. Sol. water, alcohol. Uses: germicidal soaps, manufacturing cyanogen gas, photography.

MERCURY NITRATE (Mercury Pernitrate).—(a) Mercuric salt: $2Hg(NO_3)_2.2H_2O$. (b) Mercurous salts: $2Hg(OH)NO_3H_2O$. (c) Mercurous salts: $Hg(NO_3)_22HgO.H_2O$. Colorless or white deliq. cryst. or powd. Decomposes on heating. Sol. water, nitric acid. Uses: (a) mfr. felts, ointments, as nitrating agent in making intermediates and organic chemicals, in medicine. (b) and (c) mfr. mercury acetate, cosmetics, hats, as laboratory reagent, for blue-black colors on metals, in medicine.

META CRESOL (m-Methylphenol, m-Hydroxy Toluene).—$CH_3C_6H_4OH$. M.W. 108.06. Colorless to yel. liquid, phenol-like odor. Sol. alcohol, ether, slightly sol. in water. Sp. gr. 1.037 (16 C). B.P. 202 C. Uses: medicinal, disinfectant, fumigant, mfr. synthetic resins, photographic developers, explosives.

METAPHENYLENEDIAMINE.—$C_6H_4(NH_2)_2$. Colorless needles. Sp. gr. 1.1389. M.P. 63 C. B.P. 287 C. Sol. alcohol, ether, water. Uses: mfr. azo and sulphur dyes, alkali blue, as laboratory reagent, developing agent in printing and dyeing textiles.

METATOLUYLENEDIAMINE (Diaminotoluol, Diaminotoluene).—$C_6H_3(CH_3)(NH_2)_2$. 1 3 4. Colorless crystalline. M.P. 99 C. B.P. 280 C. Sol. water, alcohol, ether. Uses: mfr. azo and sulphur colors, as developing agent in dyeing and printing textiles.

METHYL ACETONE (see also Methyl Ketone).—Mixture methyl acetate, acetone and methyl alcohol. Colorless liq. Uses: mfr. extracts, artificial leather, rubber cements, gas mantles, various cement compositions, paint, solvent in extracting perfumes, varnish remover, solvent for gums, resins, etc. and nitrocellulose, rubberizing fabrics.

METHYL BROMIDE (Bromomethane).—CH_3Br. M.W. 94.9. Colorless non-inflammable gas. Weight per gal. 14.4 pounds at 0 C. B.P. at 14 pounds, 4.5 C. M.P. −93 C. Miscible with most organic solvent; forms a voluminous crystalline hydrate with cold water. Uses: as a refrigerant, mfr. dyes and pharmaceuticals.

Methyl Monochloracetate.—$CH_2ClCOOCH_3$. M W 108.5. Clear colorless liquid with sweetish odor Irritating to the eyes and mucous membranes. Miscible with most organic solvents, very slightly sol water

Methylene Chloride (Dichloromethane, Methylene Bichloride, Carrene) —CH_2Cl_2 Colorless, non-inflam liq M W 84.930 Sp. gr 1.336 (24 /4 C) B P 39.8 C Miscible alcohol ether slightly sol. in in water Uses mfr intermediates, organic chemicals, synth. dyes, drugs and perfumes lacquers in medicine. Refrigerant biological preservative. Degreasing and spotting agent. A solvent for dewaxing lubricating oils.

Monoamyl Amine—$C_5H_{11}NH_2$. Sp gr 0 7761 (20 C) M W 87 11 Dist. range 85 -100 C Visc at 20 C 0.01018 poise F.P 45 F Molar aqueous solution has pH 11.67 Uses textile industry as lubricants leather finish in polishes, paper sizes solvent many organic compounds.

Monochlorbenzene (Chlorobenzol Benzene Chloride, Chlorbenzene Chlorbenzol Phenyl Chloride) —C_6H_5Cl Colorless liq Sp gr 1 112 (15 C) M P —45 C B P 132 C Sol. alcohol, benzene, chloroform ether insol. water Uses mfr picric acid, phenol, military poison gases, sulphur blacks and browns, synth perfumes, dinitrochlorobenzene intermediates drugs and dyes.

Naphthas, Cleaners—Special solvents of coal-tar or petroleum origin used by dry-cleaners for the removal of stains, dirt, grease, grime, etc., from clothes garments, etc.

Nickel Salts, Single and Double (Nickel Sulphate, Electrolytic Salt, Blue Salt, Nickel Ammonium Sulphate, Nickelous-Ammo-Sulphate)— Uses mfr nickel ammonium sulphate, paints, varnishes ceramics, in nickel plating blackening brass and zinc as mordant in dyeing and printing textiles catalyst for oils.

Nitrobenzene (Nitrobenzol, Oil Mirbane, Essence of Mirbane Nitrobenzide) —$C_6H_5NO_2$ M W 123.05 Yellow, oily liq, odor bitter almonds Sp gr 1.208 (15 C) M.P 5.70 C B.P 210.85 C Sol alcohol, ether very slightly sol water

Oil Tar Acid—Black liq Sp. gr 0.950–1.000 Sol. xylene. Uses source of tar acids (phenol the cresols, xylenols, cresylic acid also of tar bases) pyridine the picolines, lutidines, parvolines, quinoline etc also in mfr of disinfectants, sheep and animal dips.

Oil Turpentine.— Spirit of Turpentine volatile oil distilled from the oleoresin obtained from Pinus palustris. Colorless liquid characteristic odor and taste both becoming more pronounced and less agreeable on aging or exposure to air Sp gr 0 854–0.868. Insol. in water Uses solvent for oils, resins, etc., for varnishes vehicle for paints. Extern in embrocations, liniments, etc. For internal use the rectified oil should be used.

Oleum (Fuming Sulphuric Acid)—H_2SO_4 with free SO_3. Colorless or slightly colored viscous liq emitting choking fumes of sulphur trioxide. Extremely corrosive Sulphating and sulphonating agent.

Orthochlorphenol.—C_6H_4OCl M W 128.53 Yellow or brown liq Dist limits 173 -177 C Sp gr 1.265 at 15.5 C Uses mfr alizarines, pyrocatechol, in organic synthesis

Orthodichlorbenzene.—$C_6H_4Cl_2$ M W 146.95 Colorless liq Sp. gr 1.3254 (0 C) M P —17 6 C B.P 179 C Sol. alcohol. Uses mfr dyes, intermediates, organic chemicals as general solvent solvent for lacquers, varnishes, waxes, ether removing sulphur from illuminating gas in fumigating in preserving paints.

Orthonitrochlorobenzene (Orthonitrochlorobenzol) — $C_6H_4(NO_2)Cl$ M W 157.5 Colorless cryst. Sp gr 1.368 (12 C.) M.P 32.5° C. B P 245 7 C Sol. alcohol, ether Uses mfr intermediate and organic chemicals, dyes, chrome colors, orthoanisidine, orthonitrophenol guaiacol.

Orthophenylphenol.—$C_6H_4C_6H_4OH$ M W 170 1 White or light buff to pink, freeflowing flakes with a mild characteristic odor B.P 284° C Sol. in sodium hydroxide solutions and most organic solvent Insol. water Used as a germicide, fungicide in the rubber industry

Parachloraniline. — C_6H_6NCl. M W 127.5 Yellowish-white solid. Dist. range —229 -230 C (95% within 1.5 C) Uses mfr of chentlin yellow dyes.

Para Chlor Meta Cresol.—C_7H_7OCl M W 142.53 Colorless crystals, phenolic odor Sol. organic solvents Insol. water M.P 66 C B.P 196 C Use antiseptic preparations.

Parachlorophenol.—C_6H_5OCl. M W., 128.53 Distillation limits 218 220 C Distillation range 4 C maximum. Yellowish light brown crystalline mass, unpleasant penetrating odor Sp gr 1.306 M.P 37 C. B.P 217 C Sol alcohol, ether very slightly sol water Uses mfr dyestuffs, intermediates, hydroquinone, pharmaceutical derivatives.

Parachlorotoluene.—$C_6H_4ClCH_3$ Colorless liq Sp. gr 1.074 (15 C) M.P 7 4 C B.P 162 C Sol alcohol, benzene, chloroform, ether Uses mfr intermediates, parachlorbenzaldehyde parachlorbenzoic acid.

Para-cresol.—Crystalline mass. Phenol-like odor Sp gr 1.039 M.P 36 C B.P 202 C Uses disinfectant, fumigating compositions, cresotinic acid, dyestuffs.

Paradibromobenzene (Benzene Dibromide, Para) —$C_6H_4Br_2$ Colorless cryst. M.P 86 C B.P 219 C Sol. alcohol, benzene, chloroform, ether insol. water Uses mfr intermediates, organic chemicals, synth. dyestuffs and drugs.

Paradichlorobenzene (Paradichlorobenzol) —$C_6H_4Cl_2$ M W 146.95. Colorless cryst., pleasant odor Sp. gr 1 458. M P 53 C B.P 173 C Vapor pressure 1.5-2 mm of mercury Sol. alcohol, benzene, carbon, bisulphide, ether Uses mfr dyestuffs, intermediates, organic chemicals, insecticidal and germicidal compositions as deodorant fumigating soil mothproofing agent

Paraformaldehyde (Paraform, Trioxymethylene, Triformol Polymerized Formic Aldehyde) —(CH_2O) M W 90 04 White, crystalline powd. odor formaldehyde. M.P 162 C Sol water, insol. alcohol, ether Uses mfr pharmaceutical preparations, artificial ivory and horn, aldehyde resins waterproofing glues as a germicide, fungicide, deodorant, fumigant.

Para Tertiary Amyl Phenol. – $C_5H_{11}C_6H_4OH$ Sp. gr 0.91-0.94 (95 C) M W 164 Softening point not less than 80 C Final melting point not less than 85 C Distillation 90 bet 250 -265 C Solubility sol. 10 % aqueous KOH F P 256 F Insol water readily sol. most organic solvents. Impurities non-volatile matter not over 0 001% Free phenol, less than 0 1 Very small amounts of amyl phenyl ethers and secondary amyl phenol Uses mfr oil soluble varnish resins of phenol-formaldehyde type

Pentachlorophenol C_6Cl_5OH M W 266.36 White, crystalline solid Sol in alcohol and ether Sp gr 1 978 (22 C) M.P 188 -189 C Uses mfr germicides, insecticides and fungicides mfr wood preservatives

Perchlorethylene

Petroleum Ether (Canadol, Benzinum, Light Ligroin, Petroleum Naphtha Mineral Spirits see also Benzine) —Colorless liq distilled from petroleum Sp. gr 0 633-0 660 B.P 40 -70 C Sol alcohol, ether, chloroform benzene fixed and volatile oils. Uses as solvent.

Phenol (Hydroxybenzene Acid Phenic, Acid Phenylic, Phenyl Hydrate Phenylhydroxide Phenylic Alcohol) —C_6H_5OH White cryst. Sp gr 1.073 (20 C) M P 42 3 -43 C B.P 183 C Sol. alcohol, ether water carbon disulphide petroleum, fixed or volatile oils,

chloroform glycerine, alkalies. Uses mfr intermediates, organic chemicals, synth drugs, dyes and perfumes, phenolates, phenates, salicylic acid, phenacetin formaldehyde, diphenyloxide para-aminophenol, hydroquinone, chloranil, picric acid nitrated phenol explosives salol, phenolphthalein, phenyl esters, mercury derivatives, acidine green aurin, brilliant yellow, diazin black and numerous other dyes, germicidal compositions, antiseptic cleansing preparations, artificial tannins, synth. resins by condensation with formaldehyde coumarine anisaldehyde and other synth perfumes, paints, varnishes, paint and varnish removers, phonograph records, synth insulating materials, photographic developers, plastic compositions, synth. rubber disinfectant soaps, detergents as general preservative and disinfectants developing agent in dyeing and printing textiles preservative for glues and adhesives camphor substitute in celluloid removing ink from old newspapers, in medicine in brewing.

PHENOTHIAZINE (Thiodiphenylamine) —$C_{12}H_9NS$ M W 199 20 Yellow leaflets, or crystals. M.P 180° C Sublimes at 371 C Insol in water sol in benzene slightly sol. in alcohol and ether

PHENYLHYDRAZINE (Hydrazobenzene) —$C_6H_5NH.NH_2$. M W 108.08 Yellowish- to reddish-brown liq Sp gr 1.091 (15 C) M.P 19.6 C B P 243.5 C Sol alcohol, ether very slightly sol water Uses mfr dyestuffs, intermediates, pharmaceutical chemicals reducing agent, metallizing mirrors laboratory reagents.

PHENYL MERCURIC ACETATE.—Antiseptic and fungicide

PHENYL MERCURIC BENZOATE —$C_6H_5Hg.CO_2C_6H_5$. White crystals used in the mfr of bactericides.

PHENYL MERCURIC BORATE —$C_6H_5HgBO_3H_2$. White crystals Used as an intermediate in the manufacture of bactericides.

PHENYL MERCURIC CHLORIDE.—Antiseptic and fungicide.

PHENYL MERCURIC NAPHTHENATE.—

PHENYL MERCURY NITRATE.—$C_6H_5HgNO_3$. M P approx 180 C Uses as a bactericide and fungicide.

PHENYL MERCURIC PICRATE.—$C_6H_5HgOC_6H_2(NO_2)_3$. White crystals used in mfr bactericides.

PHOSPHINE (Amido Phenyl Acridine) —

PHOSPHORIC ANHYDRIDE (Phosphorus Pentoxide) —P_2O_5. M W 142.04 White practically odorless, amorphous, bulky powder rapidly absorbs moisture from the air Sublimes when heated. Soluble in water somewhat slowly with evolution of much heat, forming phosphoric acid similarly in alcohol Uses drying and dehydrating agent.

PHOSPHORUS OXYCHLORIDE (Phosphoryl Chloride) —$POCl_3$. Clear colorless fuming liq with pungent odor Sp. gr 1.680 (15 C) M P 1.2 C B P 110 C Solidifies −10 C Decomposed by water and alcohol Uses chlorinating agent and catalyst in making organic chemicals intermediates, dyestuffs, etc

PHOSPHORUS PENTACHLORIDE (Phosphoric Chloride) —PCl_5. Fuming white cryst decomposing in air irritating odor Sp gr 3.60 M P 148 C (under pressure) B.P 160 −165 C Sol. carbon disulphide Decomposed by water Uses chlorinating agent in making intermediates and organic chemicals, laboratory reagent chemical catalyst.

PHOSPHORUS PENTASULPHIDE (Phosphoric Sulphide, Thiophosphoric Anhydride Phosphorus Persulphide) —P_2S_5. Light yellow crystalline masses Sp gr 2.03 M.P 274 C B.P 518 −520 C Sol. alkalies, carbon disulphide Decomposed by water Uses in organic synthesis.

PHOSPHORUS TRICHLORIDE (Phosphorus Chloride) —PCl_3. M W 137.39 Clear colorless fuming liq Sp gr 1.616 (0° C) M P −111.8 C B.P 73.5 C Miscible ether benzene, carbon disulphide carbon tetrachloride Decomposed by water or moist air Uses mfr phosphorus pentachloride phosphorus oxychloride, saccharin for pro-

ducing iridescent metallic deposits chlorinating agent in making intermediates, organic chemicals, synth dyes, drugs, perfumes.

PINENE, ALPHA.—$C_{10}H_{16}$. Colorless liq. Sp. gr 0.862 (15.5 /15.5 C) B.P 155 -156 C Flash point (closed cup) 33 C Uses solvent for paints and varnishes mfr of synthetic camphor terpineol and terpin hydrate.

POLYCHLOR NAPHTHALENES (Hexachlornapthalene, Tetrachlornapthalene)

POTASSIUM ACID FLUORIDE (Potassium Bifluoride) —KF.HF M W 78.1 Colorless crystals. Sol. water Uses as an antiseptic in etching of glass.

POTASSIUM ARSENATE (Macquer's Salt) —KH_2AsO_4. M W 180.05 Colorless cryst. Sp gr 2.867 Sol. water Uses mfr fly paper insecticidal preparations as laboratory reagent preserving hides printing textiles.

POTASSIUM BICHROMATE (Potassium Dichromate, Red Potassium Chromate) —$K_2Cr_2O_7$ Yellowish-red cryst. Sp. gr 2.692. M.P 396 C B.P decomposes at 500 C Sol water Uses mfr alkaline chlorates, organic and inorganic chemicals, intermediates, poison fly paper aniline violet, coal-tar products, glass, glues, adhesives, synth. perfumes, dry colors, printing inks, alizarine, chrome alum, ceramics, linoleum, oilcloth, paints, varnishes, bichromate electric batteries, matches, match striking and pyrotechnic compositions nitroglycerine explosives, chrome pigments blueprint paper as general oxidizing and general bleaching agents discharge, photographic and laboratory reagents reagent in dyeing and printing textiles engraving and other printing purposes chrome tanning leather staining wood bleaching fats, oils, resins and waxes refining oil and tallow electroplating brass pickling in medicine.

POTASSIUM BINOXALATE (Potassium Acid Oxalate, Acid Potassium Oxalate, Salt of Sorrel, Essential Salt of Lemon, Sal Acetosella) —KHC_2O_4. White solid, hygroscopic crystalline. Sp gr 2 088 (anhydrous) Decomposes on heating. Sol. water Uses cleaning and scouring metals and wood ink stain remover photographical purposes bleaching straw

POTASSIUM BISULPHITE (Potassium Acid Sulphite) —$KHSO_3$. White crystalline powd sulphur dioxide odor Decomposes on heating Sol water insol. alcohol. Uses mfr sodium hydrosulphite, inorganic chemicals bleaching, dyeing and printing textiles bleaching tannin extracts and straw solubilizing dyestuffs tanning leather reducing agent in making organic chemicals and intermediates general antiseptic and cleansing agent laboratory reagent.

POTASSIUM CARBONATE (Salts of Tartar Pearl Ash, American Ashes Fixed Nitre, Potash Salts of Wormwood) — K_2CO_3. White, deliq powd Sp gr 2.3312 (17 C) M P 808 C Decomposes on further heating Sol Water Uses mfr potassium salts, oxalic acid, potassium cyanide inorganic chemicals glass mineral waters, food and perfume preparations, soft soaps toilet articles, ceramics, blueprint paper dry colors, printing inks, explosives explosive compositions fertilizers dehydrating agent brewing beer washing textiles wool and silk bleaching and dyeing textiles, engraving and lithography electroplating reagent tanning leather in medicine

POTASSIUM CYANIDE.—KCN White deliq amorph or crystalline powd. faint odor of bitter almonds. Sp gr 1.52. M.P and B P red heat. Sol water alcohol glycerine Uses mfr paper insecticidal compositions extracting gold and silver from ores case hardening and quenching baths in treating steel electroplating metals, reagent in assay laboratory and in making intermediates and organic chemicals fumigant for food granaries and cotton engraving and lithography assistant in dyeing and printing textiles in brass and metal industry in medicine

Potassium Fluoride.—KF M W 58 1 Colorless, cryst. hydroscopic powd. M.P 880 C Sp gr 2 48 Sol water Uses mfr ant powders as a disinfectant in etching glass as a preservative

Potassium Hydroxide (Caustic Potash, Potassa, Potassium Hydrate, Kalilange) —KOH. M W 56 11 White, deliq crystalline, solid flake or sticks. Sp. gr 2.044 M.P 380 C B P sublimes at white heat. Sol. water alcohol, ether Uses potassium salts, oxalic acid match head compositions, textile and toilet soaps, detergents, paper perfume, preparations, printing inks, dry colors bleaching textiles mercerizing cotton laboratory reagent in electroplating, photo-engraving and lithography in medicine

Potassium Sulphite —K_2S Red crystalline mass, deliq in air should be kept well stoppered. Sp gr 1.805 (20 /4° C) M.P 471 C Uses reagent in analytical chemistry depilatory

Propylene Dichloride (1,2 Dichlor Propane) —$CH_3CHClCH_2Cl$ Colorless liq Sp gr 1 16 (15 C) B.P 95 9 C Insol. in water Uses solvent for oils, fats, waxes, gums and resins liq soap cleaning and scouring compounds spot removing compounds, extraction reagent in organic synthesis.

Resorcin (Resorcinol Metadihydroxybenzene, Benzenediol) —$C_6H_4(OH)_2$ M W 110.05 Almost colorless cryst. Sp gr 1.285 (15 C) M.P 110 C B P 276 C Sol. water alcohol, benzene amyl alcohol Uses mfr phthalein and azo dyestuffs, fluorescein colors, pharmaceuticals, trinitroresorcinol, eosin hair remedies camphor substitute in celluloid laboratory reagent textile dyeing and printing in medicine

Rosin Wood (Colophony) —Natural, solid amorph. By extraction from long leaf pine wood. Grades FF I K, M N WG and WW Sp. gr approx. 1.08. M.P (drop method) 75 -85 C M.P (ring and ball method) 70 -80 C Uses same as gum rosin.

Silicon Tetrachloride —$SiCl_4$ M W 169.89 Clear, colorless, fuming liq suffocating odor Sp gr 1.5 M P 70 C B P 57.6 C Decomposition in water Uses smoke screens.

Silver Nitrate (Lunar Caustic, Lapis Caustic) —$AgNO_3$ M W 169.89 Colorless, odorless cryst Sp gr 4.352. M P 212 C Decomposes on further heating and in light. Sol water hot alcohol, and glycerine. Uses mfr mother of pearl, glass, photographic emulsions, silver salts, indelible inks, hair dyes, pharmaceutical derivatives silvering, plating, silvering mirrors laboratory reagents in medicine.

Soda, Caustic (Sodium Hydroxide, Lye, Ley Sodium hydrate, White Caustic) —NaOH White, deliq amorph solid flake or ground liq sol. Sp. gr 2 13 M.P 318 C B P white heat. Sol. water alcohol, ether glycerine Uses mfr sodium salts, oxalic acid, soap, chemical pulp, etc

Soda Ash (Anhydrous Sodium Carbonate) —Na_2CO_3 Grayish-white powd Constants vary according to grade and purity Sol water Uses mfr sodium salts, pharmaceutical products, soap, rubber boiler compounds, printing inks, dry colors, perfume preparations, synth. perfumes, glass, ceramics, fire, waterproofing and household compositions, paper paints, enamelware for re-laundering bottle and dish washing, refining tallow oil scouring wool, softening water and leather dyeing textiles in cleaning compounds in metallurgical industries.

Sodium Arsenate —$Na_2AsO_4.12H_2O$ M W 424 11 Colorless cryst. Sp. gr 1 754 M P 80 3 C Sol water slightly sol alcohol. Uses mfr lead arsenate insecticide and germicidal compositions, dry colors, printing inks mordant and assistant in dyeing and printing textiles in medicine.

SODIUM ARSENITE (Sodium Meta-Arsenite) —$NaAsO_2$. Grayish-white, amorph. powd. Sp. gr 1.87 Sol water alcohol. Uses mfr insecticides, soaps preserving hides dyeing textiles general antiseptic

SODIUM BICHROMATE (Sodium Dichromate, Sodium Acid Chromate) —$Na_2Cr_2O_7 2H_2O$ Red deliq cryst. Sp. gr 2.52 Loses water at 100 C M.P 320 C Decomposes on further heating Sol. water Uses mfr chrome alums, chrome pigments for paints, pyrotechnics, synth perfumes and dyes, intermediates electric batteries, organic chemicals, pharmaceuticals, fireworks, matches, chrome glues chrome tanning leather engraving copper plates, refining precious metals electroplating brass industry mordant in dyeing and printing textiles oxidizing agent in dyeing laboratory reagent bleaching sponges general antiseptic bleaching waxes, resins, fats, and oils waterproofing and general oxidizing agent refining petroleum products in medicine chemical film on lead and silver

SODIUM BIFLUORIDE (Sodium Acid Fluoride) —$NaF.HF$ White, crystalline powd. Decomposes on heating. Sol water Uses food preservative preservative for anatomical, etc specimens etching glass in medicine.

SODIUM BISULPHITE (Leucogen, Sodium Acid Sulphite, Sodium Metabisulphide) —$NaHSO_3$. White, crystalline powd., slight sulfurous odor Sp. gr 1 48 Decomposes on heating Sol. water Uses mfr sodium salts, cream of tartar glucose, sugar syrups, synth. dyestuffs and perfumes, intermediates, organic chemicals, tanning extracts general antiseptic, antiseptic in fermentation industries bleaching straw and cork, digesting wood pulp sterilizing brewer's casks antichlor in bleaching textiles mordants and discharge in printing and dyeing fabrics laboratory reagent depilatory in cleaning hides, tanning leather copper and brass plating preserving foods coagulating rubber latex in medicine.

SODIUM CARBONATE MONOHYDRATED (Crystal Carbonate) —$Na_2CO_3.H_2O$ White powd Loses water at 100° C Sol water Sp. gr 1.55 Uses mfr chemicals, cleaning and boiler compounds in laundry textile cleaning, photography in medicine.

SODIUM CYANIDE —$NaCN$ White, deliq crystalline granules. Sol water slightly sol alcohol. Uses solvent for precious metals in metallurgy electroplating solutions, and cleaning metals heating and treating metals source of hydrocyanic acid for insecticidal purposes fumigation in medicine. Dangerous poison

SODIUM FLUORIDE (Fluorol) —NaF White powd. or colorless cryst. Sp. gr 2.766. M P 982 C Sol. water slightly sol. alcohol. Uses mfr enamels, vermin destroyers, rat poisons as insecticide germicide flux preservative for wood and food in medicine.

SODIUM HYDROSULPHITE $Na_2S_2O_4\ 2H_2O$ Colorless, amorph cryst., which decomposes at red heat Sol water Uses discharge in dyeing and printing textiles reducing agent for removing dyes from textiles bleaching agent and ingredient of vat liquors.

SODIUM HYPOCHLORITE (Eau de Labarraque Eau de Javelle Javelle Water) —$NaOCl$ Unstable in air Stored in solution. Disagreeable sweetish odor Decomposes on heating Sol. cold water Uses mfr indigo, intermediates, organic chemicals, anthranilic acid bleaching textiles, paper pulp, etc purifying water in laundries in medicine

SODIUM METASILICATE $Na_2SiO_3\ 5H_2O$ Anhydrous white in color hydrates are white granular or crystal. Hydrates very soluble in water anhydrous slowly sol in water Uses as a cleansing agent as a detergent in kier boiling of cotton goods, de-inking paper, in laundries.

SODIUM ORTHOPHENYLPHENATE $C_6H_4C_6H_5ONa.4H_2O$ M W 264.3 White or light buff flakes or powd., with a slightly soapy odor Sol. water alcohol, acetone insol. most organic solvents. Uses as a germicide fungicide

SODIUM PENTACHLOROPHENATE.—Antiseptic and fungicide.

SODIUM PHOSPHATE (Tri-Sodium [Sodium Phosphate Tribasic, Trisodium Orthophosphate Sorensen s Phosphate]) —$Na_3PO_4.12H_2O$ Colorless cryst Sp gr 1 644 M.P 73 4° C Sol. water Uses mfr water softener boiler and cleaning compounds, photographic developers as laundry reagent tanning leather, clarifying sugar and liquors.

SODIUM SULPHIDE (Sodium Sulphuret) —(a) Na_2S (b) $Na_2S.9H_2O$ Clear colorless, deliq cryst Sp gr 1.856. Infusible. Sol. water slightly sol. alcohol. Uses mfr sulphur dyes, intermediates, organic chemicals, paper pulp glazed kid insecticidal compositions, sheep dips, depilatory agent in preparing hides denitrating rayon, ingredient of dye liquor in dyeing textiles as solvents cleaning fabrics calico printing sulphiding oxidized lead and copper ores preparatory to flotation laboratory and photographic reagent, solvent for gold in metallurgy of gold ores, oxidizing metals and electroplating reagent engraving and lithography

SODIUM SULPHITE.—(a) Na_2SO_3, (b) $Na_2SO_3.7H_2O$ Colorless, efflorescent cryst Sp gr (a) 2.0334 (b) 1.561 M P (a) 150 C (b) loses water at 150 C Decomposes on further heating. Uses mfr sulphite cellulose, sodium thiosulphate dyestuffs, intermediates, organic chemicals bleaching delicate textiles general chemical reducing agent general preservative antichlor to remove chlorine from textiles, paper etc., photographic developer, preserving sugar syrups, foods, meats treating rubber latex sterilizing beer kegs silvering glass mirrors, engraving and lithography, in medicine.

SODIUM SULPHOCARBOLATE (Sodium Phenol Sulphonate) —$C_6H_4(OH)(SO_3Na)$ M W 196 1 White crystalline powder Sol. in water and alcohol. Uses antiseptic, in pharmaceuticals.

SODIUM SULPHOCYANIDE (Sodium Thiocyanate, Sodium Sulphocyanate, Sodium Rhodanate Sodium Rhodanide) —NaSCN M W 81.07 Colorless or white amorph. powd. or heavy deliq cryst. M.P 502.3 C Sol. water, alcohol. Uses dyeing and printing textiles laboratory reagent electroplating reagent toxic insect spray in medicine in match-head compositions.

SODIUM 2-4-5-6-TETRACHLOR PHENATE.—C_6HCl_4ONa. M W 253.9 Light-tan to nearly white solid with a slight characteristic odor Sol. water alcohol, acetone insol. most other organic solvents. Uses: as a fungicide for control of molds and fungi on wood products.

STODDARD SOLVENT —Colorless refined petroleum product specially fractionated for the dry cleaning industry Specifications are outlined in the Bureau of Standards, booklet CS3-28. Flash point shall not be lower than 100 F odor sweet shall show not more than extremely slight discoloration when clean copper strip is submerged in the solvent for three hours at 212 F Distillation range not less than 50% shall be recovered in the receiver when the thermometer reads 350 F The dry or end point shall be not higher than 410 F No tolerance shall be allowed above 410 F

STYRENE (Vinyl Benzene) —C_8H_8. M W 104 14 Clear colorless liq of characteristic odor Polymerizes slowly on standing, rapidly when heated, becoming increasingly viscous until a clear glassy solid state is reached

SULPHUR DI-CHLORIDE —SCl_2 M W 102.97 Reddish-brown liq Sp. gr 1.621 at 15 C M P 78 C B.P 59 C Decomposes at 64 C Uses vulcanizing rubber substitutes and cements purifying sugar juices sulphur solvent.

SULPHUR MONOCHLORIDE (Sulphur Subchloride) —S_2Cl_2. M W 135.03. Amber to yellowish-red, fuming liq penetrating odor Sp gr 1.678. F.P 80 C B.P 135 6 C Sol. alcohol, ether benzene carbon disulphide, amyl acetate. Uses mfr rubber cements and substitutes, acetic anhydride, intermediates, organic chemicals, linseed oil substi-

tutes, military poison gas, insecticides, varnishes, waterproofing and pharmaceutical preparations hardening soft woods sulphur solvent vulcanizing rubber defecation of sugar juices finishing and dyeing textiles in medicine

1 1 2 2 TETRACHLORETHANE.—

TETRACHLORETHYLENE (Carbon Bichloride Carbon Dichloride, Perchlorethylene)—$CCl_2.CCl_2$ M W 165.83 Colorless non-inflam. liq., ether-like odor Pounds/gal. 13.5 Sp. gr 1 632. F.P −22.4 C B.P 120 8 C V.D at 15 C., lbs./cu ft. 0 438. Latent heat of vap. B T U./lb 90 1 S.H., Cal./Kg./°C or B T U./lb /°F., 216 at 20° C. Sol. alcohol, ether insol. water Uses mfr dry-cleaning soaps, detersive compounds, organic preparations as dry-cleaning solvent in organic synthesis, as general solvent.

2-4-3-6-TETRACHLORO PHENOL.—C_6HCl_4OH M W 231.8 Brown solid with characteristic phenol odor Sp. gr 1 65 at 60 /4 C Sol sodium hydroxide sol., most organic solvents insol. water Uses as a fungicide as a wood preservative

TETRACHLORONAPHTHALENE.—A chlorinated naphthalene Hard, semi-amorphous solid, pale yellow color Sol. common hydrocarbon solvent. Sp. gr 1.65–1 71 (68 /68 F) Flow point (ASTM Ball & Mod Ring °F) 625–675 Flash point 356 F Fire point, none. Viscosity (seconds, Saybolt at indicated temp.) 35 sec. at 212 F Uses as waterproofing, fireproofing, acidproofing, mildew and insectproofing agent as a plasticizer

TETRAHYDRONAPHTHALENE (Tetralin)—$C_{10}H_{12}$ M W 132.00 Colorless liq Sp. gr 0.971 B P 207.2 C. Sol alcohol ether insol. water Uses solvent for resins, waxes, fats and oils as substitute of turpentine in motor fuels.

THYMOL (Thyme Camphor Isopropylmetacresol Thymic Acid, Methylpropylphenol, Parapropylmetacresol, Hydroxy-Paracymene, Methylhydroxyisopropyl Benzene)—$C_6H_3(CH_3)OH(C_3H_7)$ M W 150.11 Colorless cryst. aromatic odor Sp gr 0.969 M.P 51.5 C B.P 231.8 C Sol. alcohol, carbon disulphide chloroform, oils, alkali, ether slightly sol. water glycerine. Uses mfr thymol derivatives, perfume preparations, cosmetics, toilet articles, tooth powd laboratory reagent food preservative embalming microscopy in medicine

TOLUOL (Toluene Methylbenzene, Methylbenzol, Phenylmethane)—$CH_3C_6H_5$ M W 92.06. Colorless refractive liq benzol-like odor Sp gr 0.8018° (15 C) M P −95 1 C B.P 110.7 C Sol. alcohol, benzol ether Uses mfr intermediates organic chemicals, benzoic acid, benzaldehyde, toluidines, pharmaceutical compounds, dyestuffs, tolidines, synth perfumery saccharin, sodium benzoate TNT rubber cements, stains and enamels solvent for coatings in making artificial leather extracting alkaloids and garbage solvent in dehairing and other degreasing operations dry cleaning agent dressing and finishes for leather etc solvent for rubber lacquers, varnishes, dopes, fat oils, rosin cleansing bone

TRICHLORETHYLENE (Chlorylene Westrosol, 1,2,2-Trichlor Ethylene) $CHCl.CCl_2$ M W 131.38. Colorless liq characteristic odor Heat of vap 104 3 C Sp. gr 1 472 F P −88 C V D 0.278. B P 86 C Pounds gal 12.23. Sol. alcohol, ether S.H 0.223. Uses mfr indigo and other dyestuffs, intermediates organic chemicals detersive soaps, pharmaceuticals perfumes paints, varnish, leather rubber solvent for fats, oil, etc degreasing bones for bone glue laboratory reagent general solvent.

2-4-5-TRICHLORPHENOL (Hydroxytrichlorobenzene) $C_6H_2Cl_3OH$ M W 197.4 Light-colored solid with a characteristic phenolic odor Sol in caustic soda solutions and most organic solvents. F.P above 60 C Uses as a fungicide.

Triethanolamine (Tri-Hydroxyethyl Amine) —$(HOCH_2CH_2)_3N$. Technical is a mixture of triethanolamine, diethanolamine and monoethanolamine. Oily almost colorless liq. ammonia odor. Sp. gr. 1.12–1.13 at 20°/20° C. B.P. 277° C. at 150 mm. Sol. alcohol, water, chloroform. Uses: mfr. synth. resins, increasing penetration of organic liquids into cellular wood fiber, for the adsorption of acetic gas, preparation of dry-cleaning soaps, for preparation of emulsions, mfr. of cosmetic soaps, for increasing the dispersion of dyes.

Vinyl Acetate —$CH_2:CH.CO_2CH_3$. M.W. 86.03. Colorless liq. Sp. gr. 0.9342 (20°/20° C.). B.P. 103° C. Refract. index 1.3958. F.P. −5 to 8° C. Uses: mfr. synthetic vinyl resins.

Vinyl Chloride (Ethenyl Chloride, Chloroethylene, Chloroethane) —$CH_2:CHCl$. M.W. 62.48. Gas. B.P. −18° C. at 760 mm. Sp. gr. at 20°/20° C. 0.9121 and 0.9730 at −15°/4° C. Uses: synthesis.

Wax Japan (Japan Tallow, Insect Wax, Vegetable Wax of Japan, Sumac Wax) —Pale yellow flat cakes. Derived from Rhus. Natural. Sp. gr. 0.970–0.980. M.P. 53° C. Saponification No. 210–220. Iodine No. 5–12. Acid No. 7.33. Sol. benzol, naphtha. Uses: mfr. furniture, shoe and floor polishes, candles, wax matches, leather polishing and finishing compositions, substitute for beeswax.

Xylol (Xylene, Dimethylbenzene) —$C_6H_4(CH_3)_2$. M.W. 106.08. Ortho, meta, para. Colorless, mobile liq., characteristic odor. Sp. gr. (o) 0.870, (m) 0.8668, (p) 0.8621. M.P. (o) −27.1° C., (m) −53.6° C., (p) 15° C. B.P. (o) 144° C., (m) 139° C., (p) 138° C. Sol. alcohol, ether. Uses: mfr. dyestuffs, intermediates, organic chemicals, artificial musk, trinitroxylene, removal of naphthalene from illuminating gas, solvent in making rubber cements, lacquers, and varnishes, in microscopy.

Zinc Chloride (Butter of Zinc) —$ZnCl_2$. White, deliq. granules. Sp. gr. 2.91. M.P. 262° C. B.P. 730° C. Sol. water, alcohol, glycerine, ether. Uses: mfr. dyestuffs, organic and inorganic chemicals, intermediates, auramine, malachite green, methylene blue, rayon, tinning flux, soldering fluids, vulcanized paper and paperboard, parchmentized paper, fireproofing compositions for wool and textiles, metal burnishing and polishing compositions, cold water glues and adhesive preparations, electric batteries, as laboratory reagent, mordant in dyeing and printing fabrics, carbonizing agent in treating wool, mercerizing liquors, resist in dyeing and printing textiles, sizing and weighting silks and other textiles, chemical catalyst, wood preservative, treating railroad ties and poles, general disinfectant and preservative, paint pigments, purifying petroleum and petroleum distillates, vulcanizing rubber, coating metals, etching glass, embalming, taxidermy, black nickel plating, in medicine.

Zinc Chromate (Double Salt) —$ZnCrO_4$ and $K_2Cr_2O_7$. Yellow cryst. powd. sol. acids. Uses: mfr. pigments, paints, varnishes.

Zinc Cyanide —$Zn(CN)_2$. White powd. Decomposes on heating. Sol. dilute mineral acids. Uses: mfr. pharmaceutical preparations, brass, alloy, gold and zinc plating, chemical reagent in various processes, in medicine.

INDEX

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